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## User Manual for Graphical User Interface Version 2.4 with Fire and Smoke Simulation Model (FSSIM) Version 1.2

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## 1.0 INTRODUCTION

The collaborative work of Hughes Associates, Inc. (HAI), the Naval Research Laboratory, and a group at Mississippi State University resulted in development of a simulation system including a Graphical User Interface (GUI) for setting up simulations and for visualization of results. The simulation environment as shown in Figure 1.1 provides a runtime environment for a third-party Fire and Smoke Simulator (FSSIM) [1,2], developed by HAI. This user's manual provides documentation of the GUI and detailed discussion of features of the output display. The CAD processing is a separate, complex piece of software which partially automates extraction of the AutoCAD data to reconstruct the 3D information and store it to the database [3]. The database schema will not be discussed in this document.

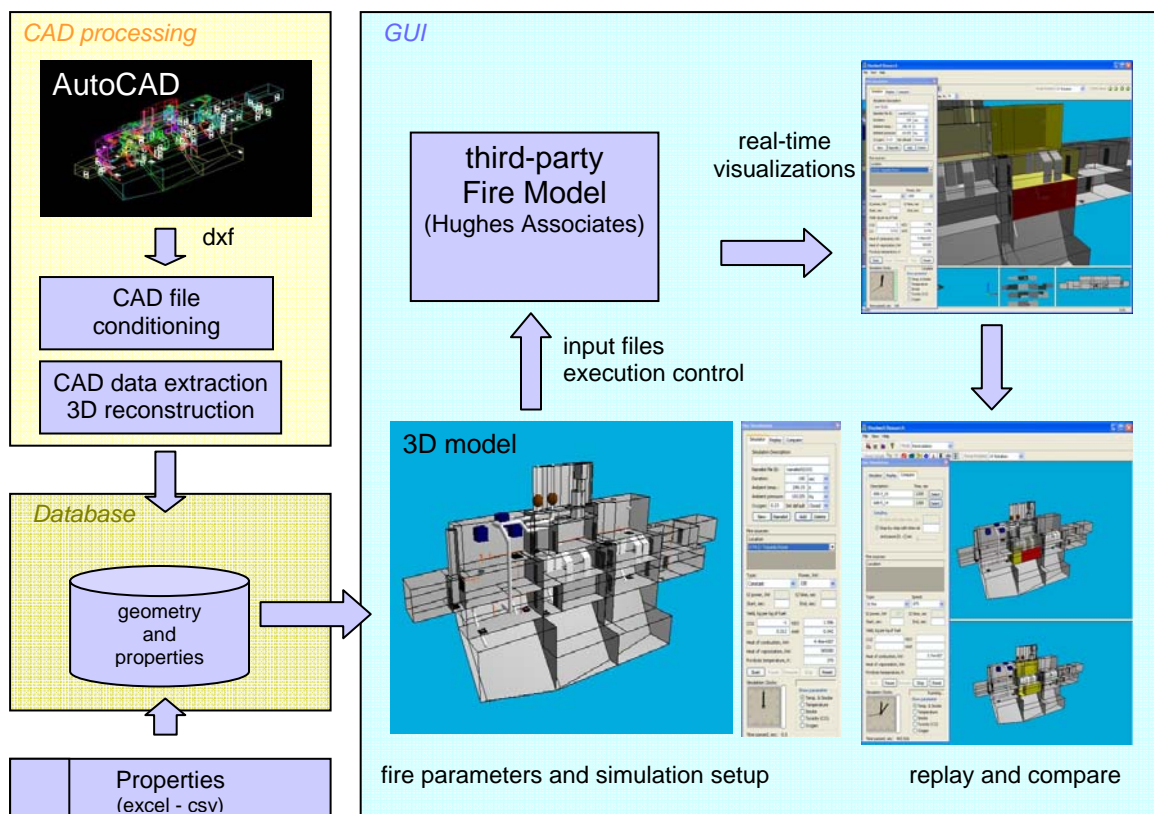


Figure 1.1 Simulation Environment

## 2.0 INSTALLATION AND RUNNING

### Minimum Computer Requirements:

(Note that the video and main memory requirements are a function of the size of the geometry or number of compartments you wish to run. Also with the myriad of CPU, memory, graphics card, and operating system combinations, performance can vary greatly.)

#### System Summary:

- Operating System: Windows XP or 2000 (not tested on older versions)
- Processor: 1.8 GHz Pentium 4 Processor or equivalent for desktop  
1.7 GHz Pentium M or equivalent for laptop
- Total Physical Memory: 512 MB RAM

#### Display:

- Adapter Type: Any with great OpenGL acceleration
- Adapter RAM: 128 MB Video RAM
- Resolution: 1280x1024 screen resolution

#### Other requirements:

- a 3-button mouse (or mouse with wheel)
- MYSQL database software (recommend MySQL 4.1)

### Checking Computer Requirements:

To check to see if your computer meets the minimum requirements given above, several of the parameters listed above can be determined by following these instructions. First, click on “**Start**” then click on “**All Programs**”, then “**Accessories**”, then “**System Tools**”, then “**System Information**” to bring up the System Information window. When this window first appears, you should see the **System Summary** information in the right side of the window which contains the **OS Name**, **Processor** (which should include speed in MHz or GHz), and **Total Physical Memory**. To see graphics related parameters, in the left side of the window, click on the plus symbol beside the **Components** item to expand it, then select **Display**. Now the right side of the window should contain **Adapter Type**, **Adapter RAM** (Video RAM), and **Resolution**.

### To install the software from the enclosed CD:

1. Copy the entire CD contents to your hard drive in a directory of your choice (make a note of where it is installed).
2. This software depends on the MySQL database software, so if you do not already have it installed, follow the instructions under “MySQL Installation” below.



3. From the command prompt (one way to access: click on “Start”, click on “Accessories”, click on “Command Prompt”), change to the directory where the CD contents were installed.
4. From that prompt, type “**cd Application**”.
5. From “...../Application>” prompt, type “**cd Databases**”.
6. If you have added MySQL commands to your PATH (when the MySQL installation wizard was run and the step h.ii followed under installation on pg. 4), from “...../Databases>” prompt, type the command  
“**mysql --user=root < loadDemos.sql**”.
7. Exit from the Command Prompt environment and go back into Windows environment.
8. From Windows Explorer, change to the directory where you have installed the CD contents.
9. Double click on “Application”.
10. Double click on “Executable”.
11. Double click on “FireGUIv2.4” to run the software.

### **Downloading and Installing MySQL**

This document provides a brief guide to downloading and installing the MySQL database server software on a Microsoft Windows-based PC. It is recommended to have your system administrator install this, especially if you are unfamiliar with installation procedures.

#### **Downloading**

- 1) There are a lot of information and downloads available on the MySQL website, which can make navigating to the correct download link challenging. The following path can be followed to reach the correct download page from the MySQL homepage. *(NOTE: As of this writing (Sep. 2006), the correct download page is accessible via the following link: <http://dev.mysql.com/downloads/> Skip to Step 2, if this link works)*
  - a. Go to the MySQL homepage: <http://www.mysql.com/>
  - b. In the column on the right side of the webpage, select “**Downloads**”
  - c. This should bring you to the “**MySQL Downloads**” page.
- 2) Once at the “**MySQL Downloads**” page, look for the heading “**MySQL Community Edition -- Database Server & Client**”. Under this heading, there should be a section titled “**Older Releases:**” with a link for the “**MySQL 4.1 -- Previous GA release**”. Follow this link.
- 3) The page that comes up will provide numerous links to different operating systems. Scroll down the page until the heading “**Windows downloads**” is seen.

- 4) Choose either the complete package (“**Windows (x86)**”) or the essentials package (“**Windows Essentials (x86)**”) by selecting the applicable “**Pick a mirror**” link.
- 5) On the next page, fill out the requested information (if you like), or just follow the link to the downloads (on the bottom of the page).
- 6) Select a download server (“mirror”) from which to download the software.

### Installing

- 1) Unzip the downloaded file using a file decompression program (e.g. WinZip) or use the functionality built into Windows XP, if available.
- 2) Open the installer file (Setup.exe) by double clicking it. As suggested in the Network Model documentation, the default selections can be followed in the install process.
- 3) At the end of the initial install process, the checkbox for “Configure the MySQL Server” is checked by default. Leave this checked to configure the server when you finish the install process. Click “Finish”.
- 4) When going through the Server Configuration Wizard screens, most of the items can be left as defaults, though some will need to be altered as appropriate (namely, step h.ii. and step i below):
  - a. Configuration Type: “**Detailed Configuration**” (default)
  - b. Server Type: “**Developer Machine**” (default)
  - c. Database Usage: “**Multifunctional Database**” (default)
  - d. Drive for InnoDB File. Simply click the “**Next >**” button to keep the defaults
  - e. Approximate Number of Connections: “**Decision Support (DSS)/OLAP**” (default)
  - f. Networking Options: “**Enable TCP/IP**” (checked by default)
  - g. Character Set: “**Standard Character Set**” (default)
  - h. Windows Options:
    - i. “**Install as Windows Service**” (checked by default)
    - ii. “**Include Bin Directory in Windows PATH**” (not checked by default). This item should be CHECKED.
  - i. Security Options: “**Modify Security Settings**” (checked by default). This item should be UNCHECKED. This will gray out the other settings.
  - j. On the next screen, the “**Execute**” button should be clicked to finish the configuration.
- 5) These steps complete the installation of MySQL. Below are instructions to quickly check for a successful installation.

## Testing

- 1) After completing the installation wizard, in a command prompt window (see windows help if you don't know how to do this) type "**mysql --user=root**" to see if it successfully connects to the database server. It should give you a prompt "mysql>".
- 2) At the "mysql>" prompt, type "**show databases;**" to see the default databases. If you have been successful, you should see on your monitor at least the following (if previously installed you may see additional databases in the list):

```
mysql> show databases;
+-----+
| Database |
+-----+
| mysql    |
| test     |
+-----+
2 rows in set (0.06 sec)
```

- 3) Type "quit" to exit. Now you should be ready to continue with step #3 from the above section "To install the software from the enclosed CD".

## **Directory Structure**

On the enclosed CD, the FireModelNetworkGUI\_V2.4 directory (shown in Figure 2.1) contains a subdirectory called Application. The Application directory contains three subdirectories: Databases, Executable, and Images.

The Databases directory contains four demonstration databases and a script to load them. The Executable directory contains the GUI executable plus its required dll files, two configuration files called Options.xml and dbconfig.txt, the HAI network model executable (version 1.2), and a subdirectory, simrep, which serves as a simulation repository for storage of results of simulations. The Images directory contains graphical images used by the GUI.

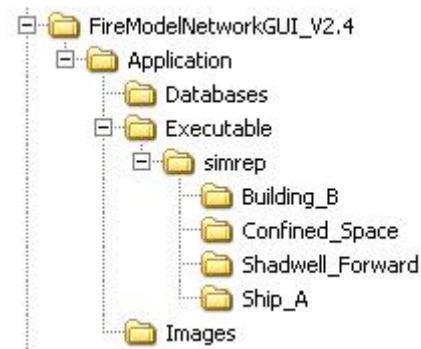


Figure 2.1 Directory Structure on the Enclosed CD

## **Software has been tested on the following which meet or exceed minimum computer requirements:**

- 1) 2.6 GHz Pentium 4 desktop, 512 MB RAM, Windows XP, ATI Radeon Fire GL 8800 w/128 MB Video RAM, running at 1280x1024. This machine performs very well on all demo databases.

- 2) 1.7 GHz Pentium M laptop, 512 MB RAM, Windows XP, ATI Mobility Fire GL T2 w/128 MB Video RAM, running at 1400x1050 screen resolution. This machine performs very well on all demo databases.
- 3) Dual Processor AMD Athlon 2400+, 2 GB RAM, Windows 2000 SP4, Nvidia GeForce4 Ti 4400 w/128 MB Video RAM. This machine performs very well on all databases.

**Software was also tested on the following which fall below the minimum requirements in one or more categories:**

- 1) 1.8 GHz Pentium 4 desktop, 256 MB RAM, Windows XP, Nvidia GeForce2 MX/MX 400 w/64 MB Video RAM, running at 1600x1200 screen resolution. This machine performed very well on graphics and satisfactory on simulations.
- 2) 2.4 GHz Pentium 4 laptop, 512 MB RAM, Windows XP, ATI Radeon 7500C w/32 MB Video RAM, running at 1280x1024 screen resolution. This machine performed satisfactory on Confined\_Space; not as good on Building\_B and Ship\_A.
- 3) 2.8 GHz Pentium 4 laptop, 512 MB RAM, Windows XP, ATI Mobility Radeon 7500 w/32 MB Video RAM, running at 1024x768 screen resolution. This machine had difficulty loading the more complex geometries.
- 4) 1.6 GHz Pentium M, 768 MB RAM, ATI Mobility Radeon AGP w/16 MB Video RAM, running at 1024x768 screen resolution. This machine performed poorly on all databases.
- 5) On an approximately 5 year old laptop of unknown speed, 256 MB RAM, Windows 2000, S3 Savage/IX w/8 MB Video RAM, running at 1024x768 screen resolution. This machine performed poorly on all databases.

### 3.0 QUICK START AND INSTALLATION TEST

This section provides a very simple example of the steps to run a simulation. Successfully following these steps and seeing simulation results similar to the final step should also verify that the installation was correct. Doubleclick on the FireGUIv2.4 executable to start.

Step 1: The Database Selection dialog (shown in Figure 3.1 ) pops up. From the drop down menu, select the Confined Space database (Confined\_Space) and click OK

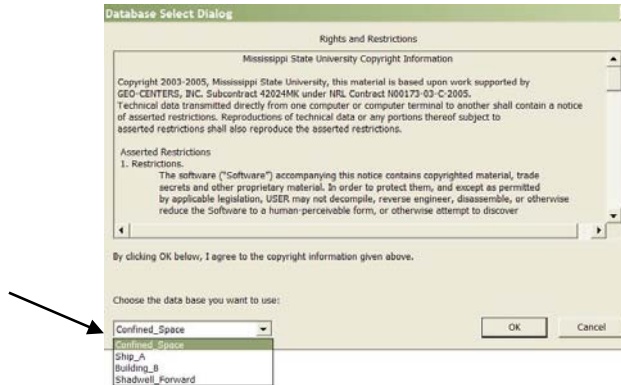


Figure 3.1 Database Selection

This should bring up the main Fire Model Network GUI window.

Step 2: Click the Fire Simulation button as shown in Figure 3.2.

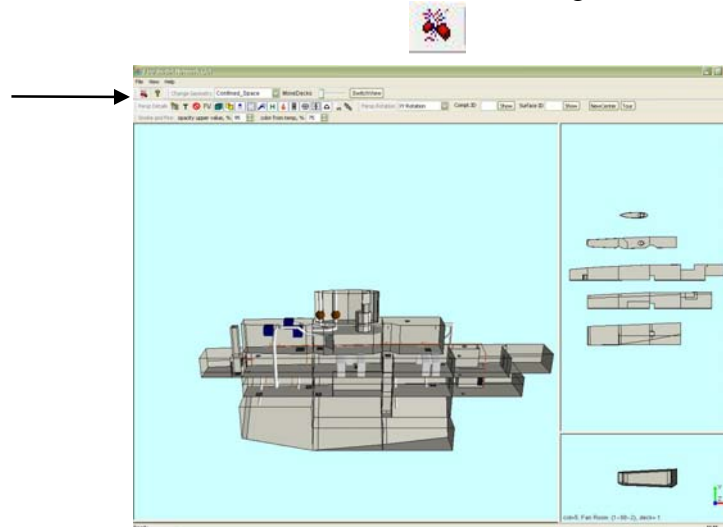


Figure 3.2 Fire Simulation Button Location

Two new popup windows should appear named Fire Simulation and Object State Editor.

Step 3: In the Fire Simulation popup (shown in Figure 3.3), by default one fire source has already been added and it defaults to the first compartment. Additional fire sources can be added with the *Add Fire* button, but for this test only use the one specified in the next step.

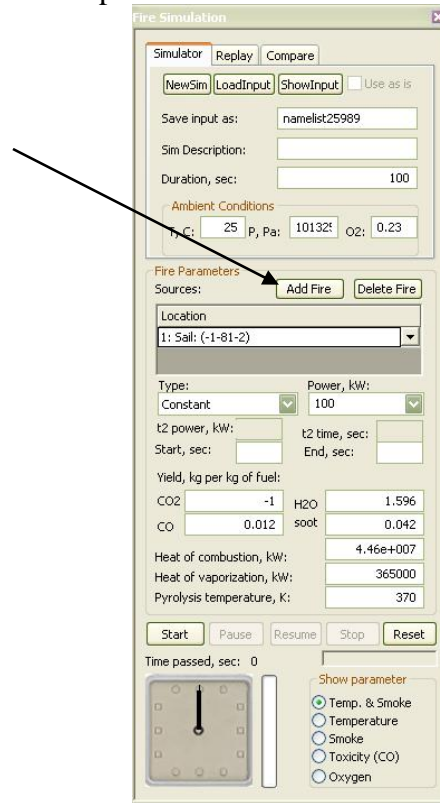


Figure 3.3 Fire Simulation Popup

Step 4: Change the fire source location to compartment 13, Torpedo Room (Figure 3.4)

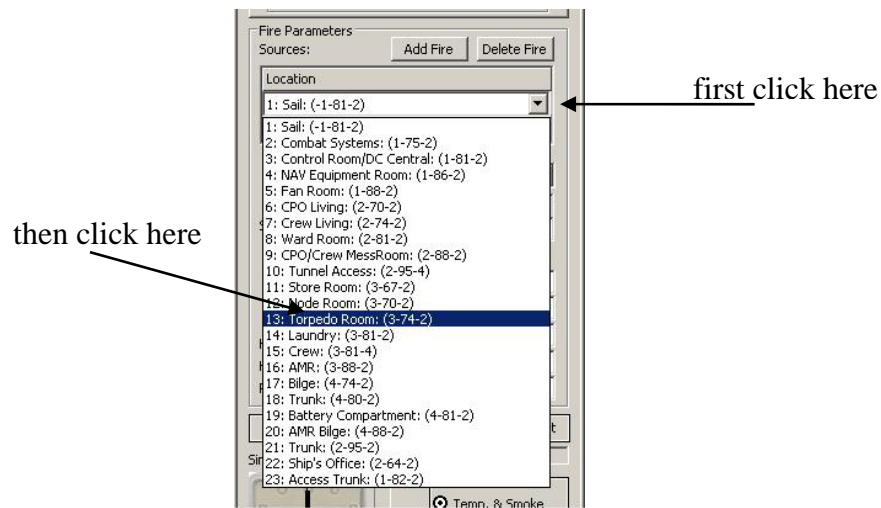


Figure 3.4 Selecting Fire Source

Step 5: Change the Power to 1000 (Figure 3.5)

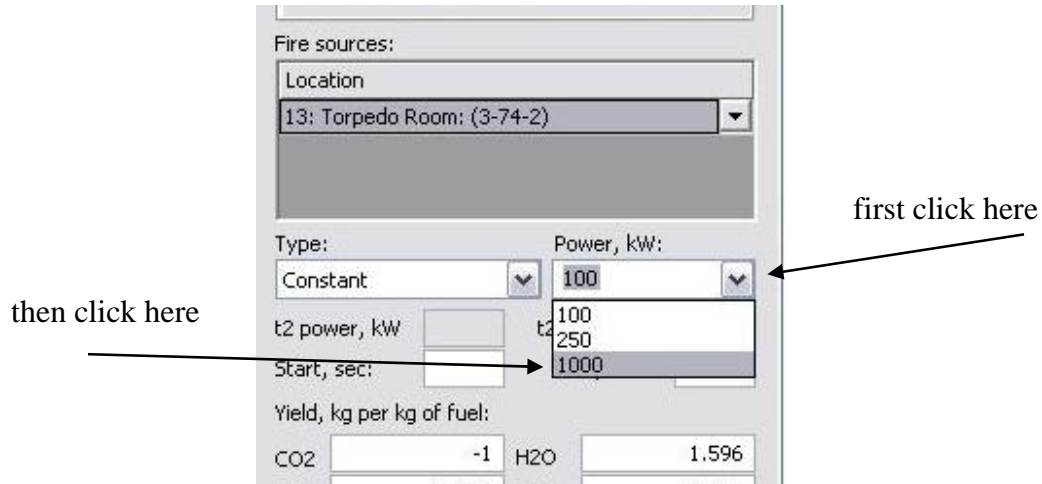


Figure 3.5 Power Settings

Step 6: In the object state popup window (Figure 3.6), check the *Include FrameBays* box. This currently applies only to the Confined\_Space.

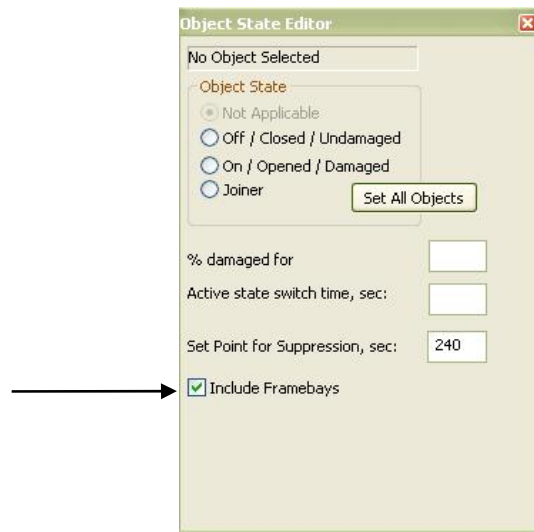


Figure 3.6 Including Framebays in the Object State Editor

Step 7: In the Fire Simulation popup (Figure 3.7), Click the *Start* button

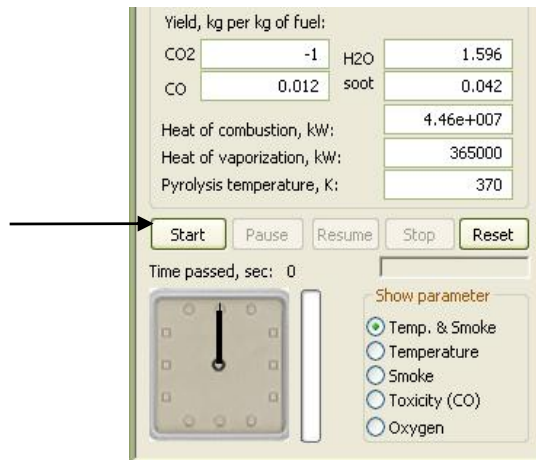


Figure 3.7 Start Button Location

Step 8: The program should start running and in a few seconds, you should see compartment 13 turn yellow, then red as simulation runs, and another compartment turn yellow as shown in Figure 3.8. The simulation should stop when the time reaches 100 seconds.

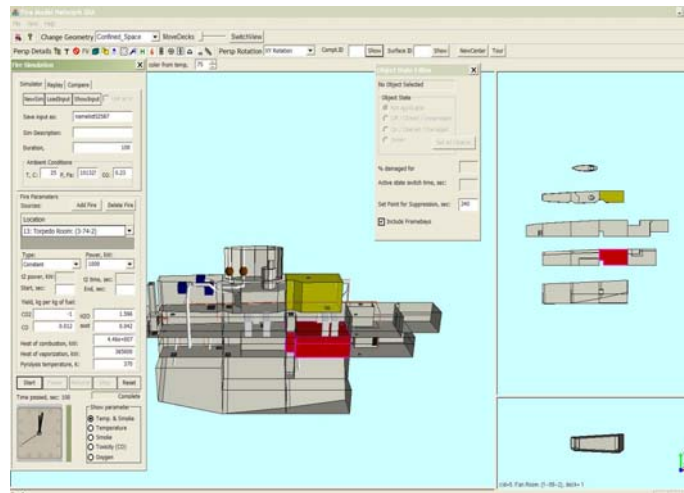


Figure 3.8 Simulation Visualization

The remainder of this document provides more details on setting up, running, and viewing simulations.



## 4.0 DATABASE SELECTION

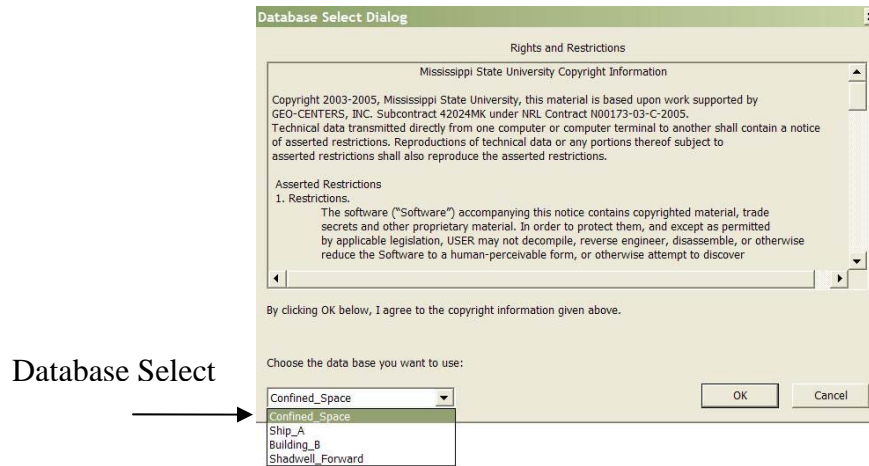


Figure 4.1 Database Selection

When the application is started, a dialog box (shown in Figure 4.1) is displayed for selecting the database. (For more details on the names which appear in the drop-down list see Section 12.1.1.) This dialog box also contains the copyright information.

## 5.0 GUI LAYOUT

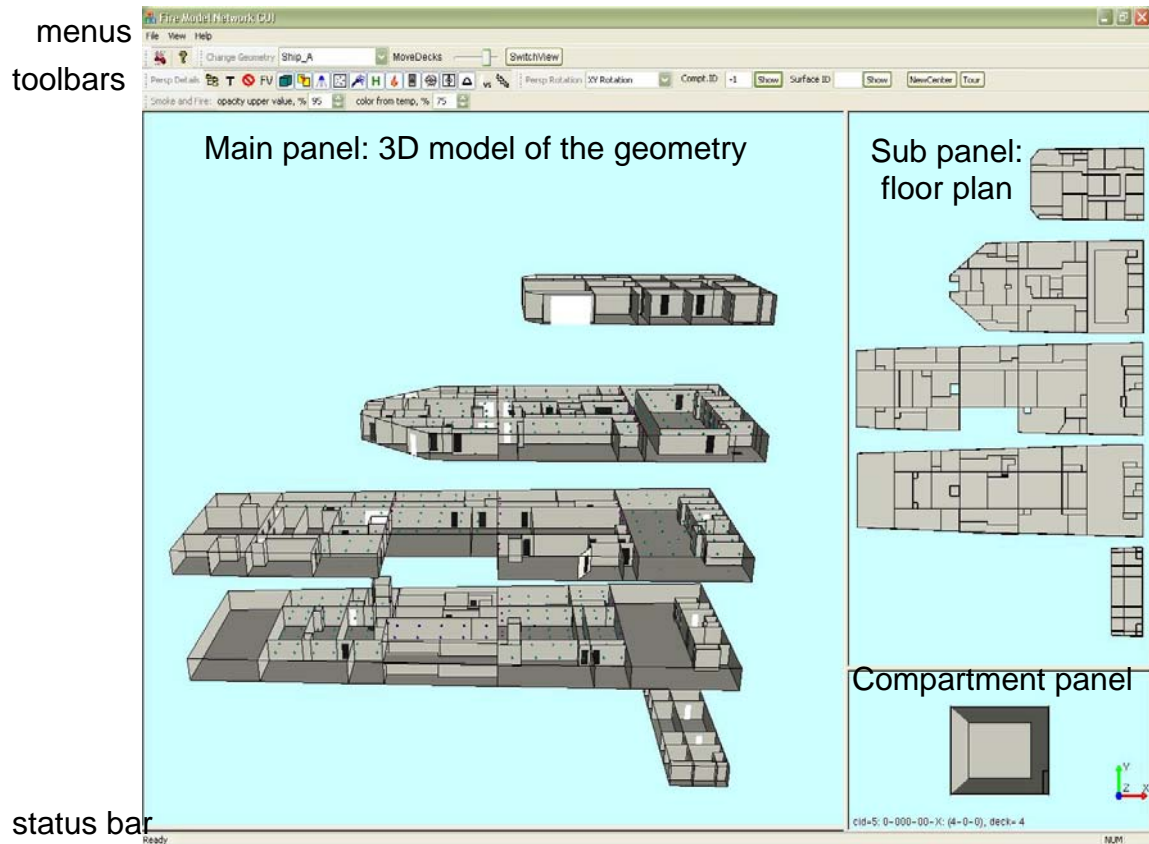


Figure 5.1 Graphical User Interface Layout

The GUI consists of six major components (Figure 5.1): menus, toolbars, status bar, main panel displaying the 3D model of the geometry, and two small panels displaying a single selected compartment and a floor plan view of the model.


### 5.1 Panels and Views

The main panel occupies the largest portion of the screen and normally displays the 3D model of the geometry. The other panels display another view of the ship or an individual compartment.

There are currently three views which can be displayed in the graphics panels: 1) A 3D model of the geometry which is used for selecting and setting the initial states of various objects (e.g., doors, fans, hatches) and displaying simulation results, 2) a 3D view of a single compartment which is used for selecting and setting states of a bulkhead which has been damaged, and 3) a floor plan view which shows a floor plan (similar to blueprint) of a ship or building. Section 13.0 explains in more detail the behavior of the different panels and views.

## 5.2 Resizing Panels

By default the main panel is larger than the other ones. The borders can be changed by dragging them to the desired locations (shown in Figure 5.2). The panels can be resized using the zoom in-out feature.

Place the cursor on the border (it will change its regular arrow-like shape to )  
Press the left mouse button and drag the border to the desired location

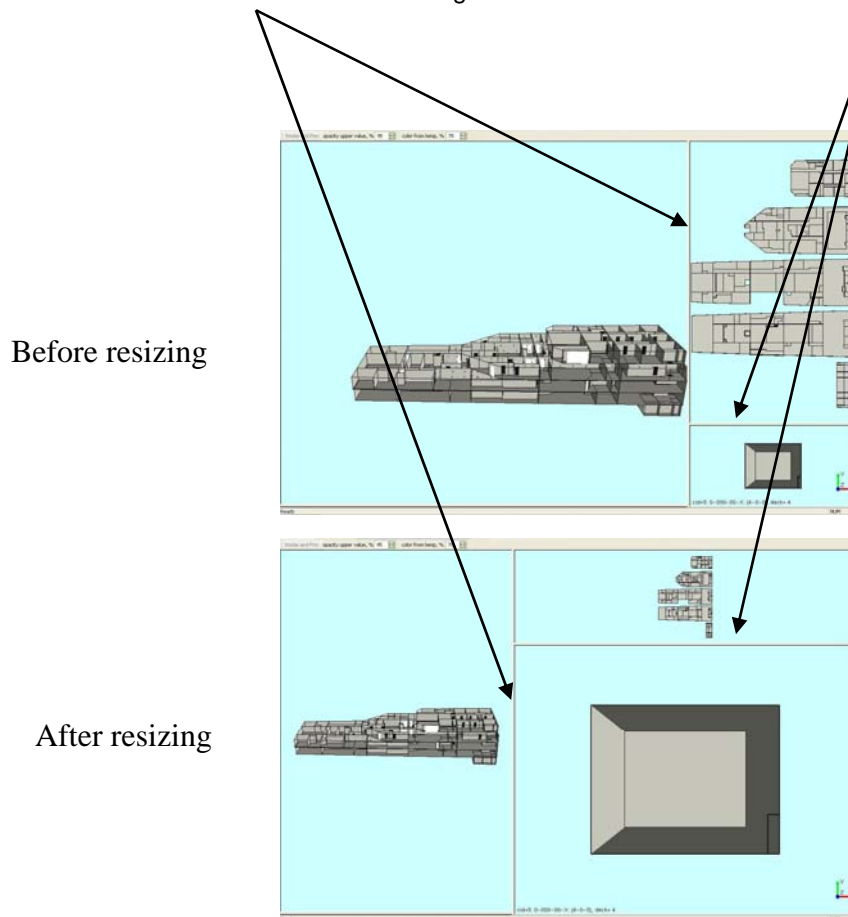


Figure 5.2 Panel Resizing

### 5.3 SwitchView

There is a *SwitchView* button (shown in Figure 5.3) which will switch the main panel's view with that of the sub-panel (the upper right panel). This provides a quick way to swap the plan view to the main panel for easier selection of compartments, and then to swap it back to 3D view as desired without having to resize the panels by dragging their borders.

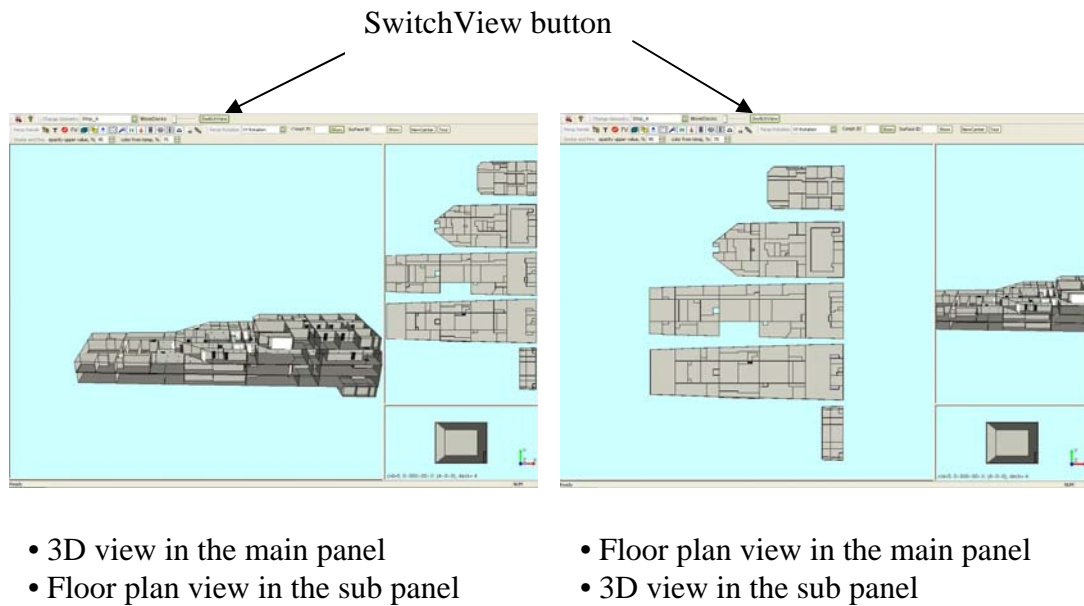


Figure 5.3 Switching Views

## 6.0 TOOLBAR

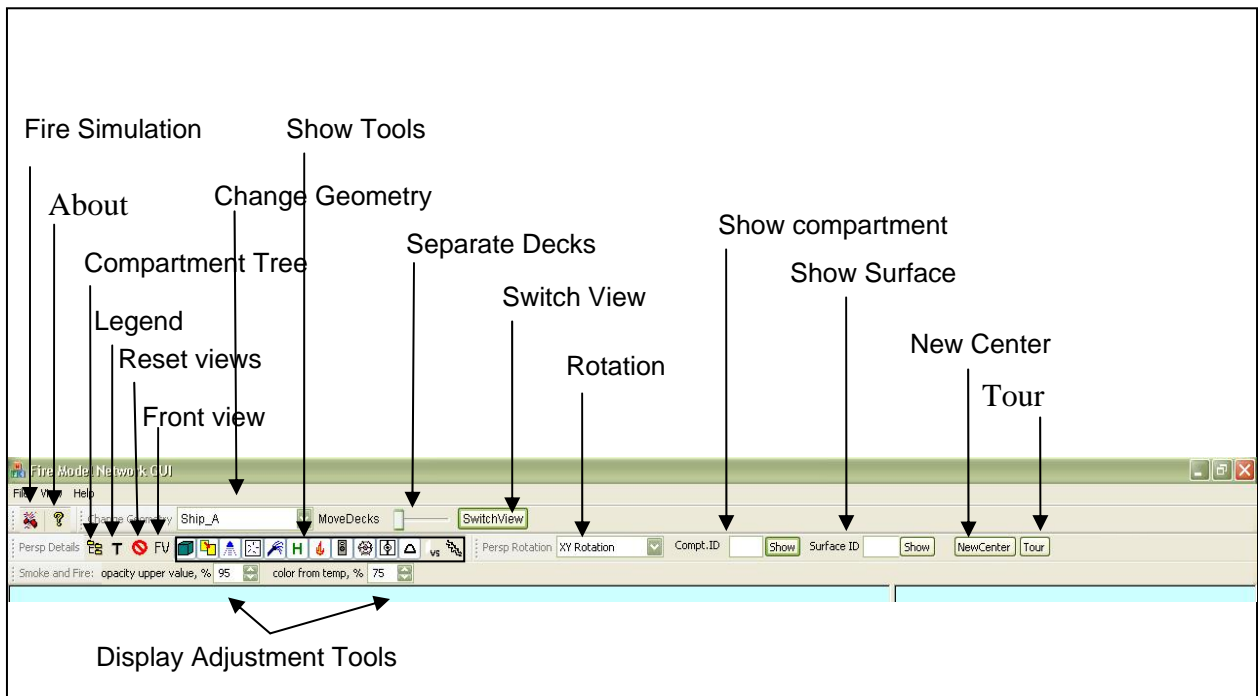



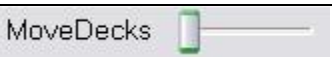





















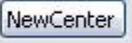



Figure 6.1 Toolbar Components

Figure 6.1 shows the location of the toolbar components. Below is a reference Table 6-1 showing the icon or symbol, name of the tool, description of the tool, and reference to the section which explains the details of the tool.

Table 6-1 Toolbar Components

Icon / Symbol	Tool Name	Description	Reference Section
	Fire Simulation	Opens two dialogs that are used to run, replay, or compare fire simulations	Section 8.0
	About	Same as Help → About menu. Shows information about the application	Section 12.3
	Change geometry	Changes the geometry (model) to the one selected in the drop down list	---
	Move (Separate) Decks	Slider to separate decks in the 3D view	Section 7.4
	Switch View	Switches between 3D view and floor plan view	Section 5.3

	Compartment Tree Browser	Provides a tree structure of checkboxes to show or hide the compartments or decks	Section 10.0
	Legend	Shows color map legend	Section 11.0
	Reset views	Resets views and panels to default positions	Section 7.5.1
	Front View	Sets front-view position of the geometry in the 3D view (for ships this sets view to starboard side)	Section 7.5.2
	Surfaces	Shows or hides surfaces (walls) to toggle between solid surfaces and wire-frame model	Section 9.1
	Edges	Shows or hides edges for each surface	Section 9.1
	Suppression	Shows or hides suppression system	Section 9.2
	Ventilation	Shows or hides ventilation system	Section 9.3
	Water Mist	Shows or hides water mist system	Section 9.4
	Inert Gas	Shows or hides inert gas system	Section 9.4
	Firemain	Shows or hides firemain system	Section 9.4
	Doors	Shows or hides doors and archways	Section 9.5
	Scuttles	Shows or hides scuttles	Section 9.6
	Hatches	Shows or hides hatches	Section 9.6
	Ratholes	Shows or hides ratholes	Section 9.7
	Virtual Surfaces	Shows or hides virtual surfaces	Section 9.8
	Damaged Surfaces	Shows or hides damaged surfaces (walls)	Section 9.9
	Rotation	Selects rotation mode for the 3D model	Section 7.1
	Show Compartment	Highlights the compartment with the given id	Section 9.10
	Show Surface	Highlights the surface with the given id	Section 9.11
	New Center	Calculates new center of the model that is used for rotations	Section 10.1

	Tour	Takes through a tour along a fixed path	Section 7.6
Smoke and Fire: opacity upper value, % <input type="text" value="95"/> <input type="button" value="+"/> <input type="button" value="-"/> color from temp, % <input type="text" value="75"/> <input type="button" value="+"/> <input type="button" value="-"/>	Display Adjustment	Adjusts visualization of smoke and fire	Section 14.0

## 7.0 GRAPHICAL INTERACTIONS

This section covers basic mouse interactions within the viewing windows, and a few other graphical elements (buttons and sliders) which control the display.

### 7.1 Rotate

The 3D model can be rotated by moving the mouse while keeping the left mouse button pressed (preferred method) or by using the cursor keys (arrow keys) on the key board. The up/down arrow keys rotate about the X axis; the left/right arrow keys rotate about the Y axis. Some users prefer the control given by using the arrow keys.

There are four modes of rotation that are controlled by the rotation tool shown in Figure 7.1.

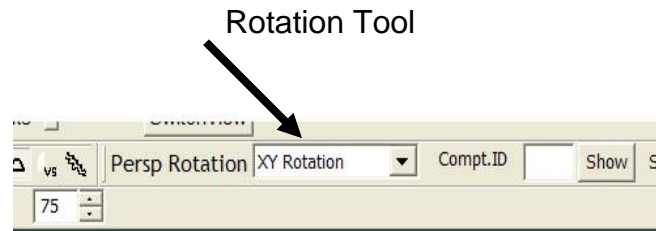


Figure 7.1 Rotation Tool

The modes are:

1. X Rotation
2. Y Rotation
3. X or Y Rotation
4. XY Rotation (default)

**Note:** The X and Y axis for Section 7.1.1 through Section 7.1.4 refer to the screen axes, not geometry axes. The screen X axis runs left and right, the screen Y axis runs up and down.



### 7.1.1 X Rotation

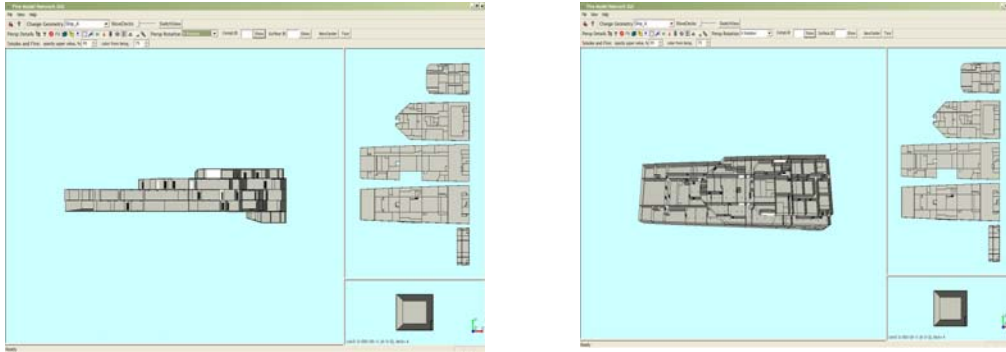


Figure 7.2 X Rotation

In this mode the ship model can be rotated only around the x-axis (horizontal one) by moving the mouse up and down. Left and right movements of the mouse are ignored. To make the above example clearer, the model has been first rotated to the front view position as shown in the left picture of Figure 7.2. The right picture of Figure 7.2 above shows the model rotated around the x-axis.

### 7.1.2 Y Rotation

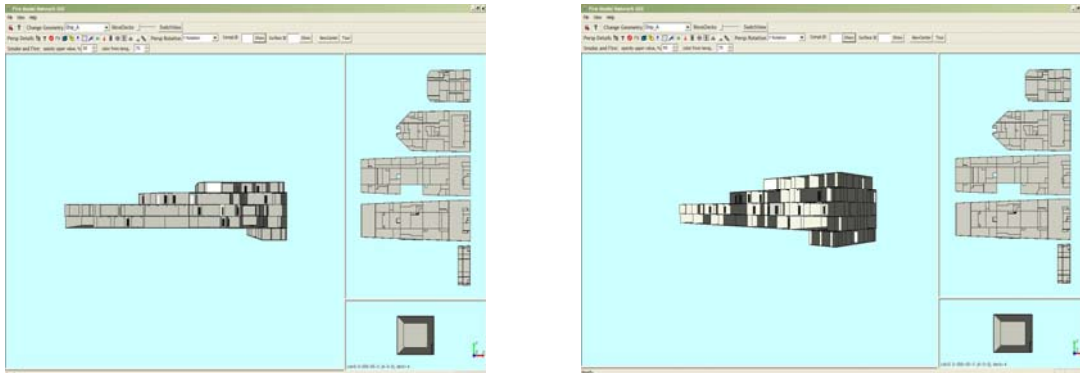


Figure 7.3 Y Rotation

In this mode the ship model can be rotated only around the y-axis (vertical one) by moving the mouse left and right. Up and down movements of the mouse are ignored. To make the above example clearer, the model has been first rotated to the front view position as shown in the left picture of Figure 7.3. The right picture of Figure 7.3 shows the model rotated around the y-axis.

### 7.1.3 X or Y Rotation

In this mode, the GUI picks the first mouse movement, after pressing the left mouse button. If it is up or down, it automatically switches to the *X Rotation* mode. If it is left

or right, it switches to *Y Rotation*. Releasing the mouse button returns the GUI rotation mode to the *X or Y Rotation*.

#### 7.1.4 XY Rotation

In this mode, the ship model is rotated around the center of the model. The model can be rotated about both the horizontal and vertical axes simultaneously.

### 7.2 Zoom In and Out

The 3D model can be zoomed in and out by moving the mouse up and down, respectively, while keeping the middle mouse button pressed. Note that the mouse should be a three button mouse. If the mouse has a wheel as the middle button, press and drag it instead of rolling it. In Figure 7.4, the middle picture below shows the original scene at left zoomed in and the right picture shows the scene zoomed out. If you do not have a three button mouse, you may hold down the Shift key and press the right mouse button while dragging it up or down to zoom.

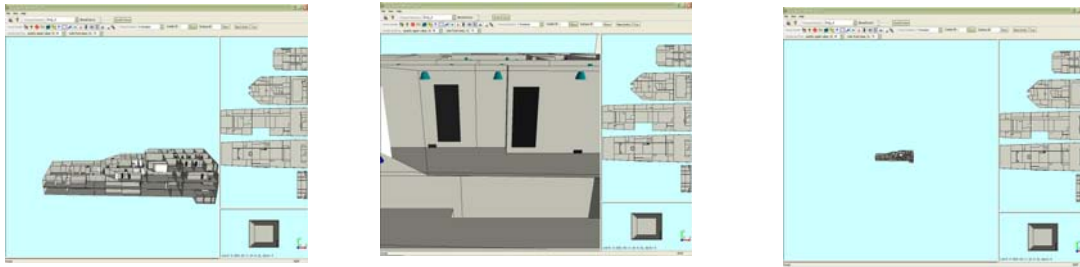


Figure 7.4 Zooming In and Out

### 7.3 Move/Translate

The 3D model can be moved inside the panel by moving the mouse, while keeping the right mouse button pressed as shown in Figure 7.5.



Figure 7.5 Translating Left and Right

## 7.4 Deck Separator Slider

The Deck Separator Slider (*MoveDecks*) shown in Figure 7.6 is provided as a feature to assist viewing of the interior of a 3D model. Compartments which have at least one surface which lies on the external boundary of the model (between the ship/building and the environment) can be viewed by simply rotating the model, since the surfaces of a compartment facing the viewer are made transparent. However, interior compartments completely surrounded by other compartments cannot be seen normally.

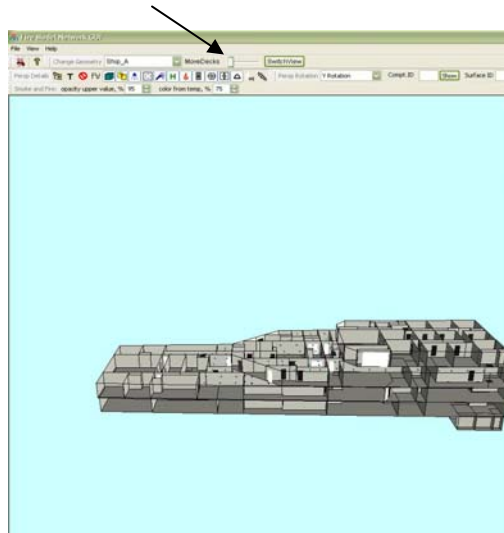


Figure 7.6 *MoveDecks* Slider at Initial Position

Dragging the slider bar to the right with the left mouse button pressed will introduce spacing between the decks/floors so that viewing of interior compartments is possible as shown in Figure 7.7. Returning the slider bar all the way to the left removes this spacing.



Figure 7.7 After Moving the *MoveDecks* Slider to the Right

## 7.5 Preset Positions

Sometimes after working with a model and performing rotation, zooming, and translation, the user can either become disoriented with respect to the model, can cause the geometry to move out of the viewing window, or simply desires to return the model to its default viewing position. Two buttons are provided to assist with restoration of particular views as shown in Figure 7.8. Any geometry and corresponding database could have different orientations depending on the decisions made by the AutoCAD drafter.

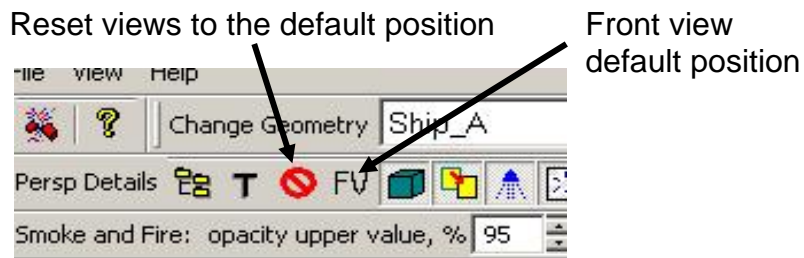


Figure 7.8 Reset and Front View Button Positions

### 7.5.1 Reset Views

This button resets the rotation, zooming, and translation to the default position in each panel and restores the panels to their default sizes. It also restores the MoveDecks slider to its initial position (no deck separation in the 3D view) and restores the compartment panel to its initial state. The default position is with the geometry centered in the panel, entirely visible, and viewed at an angle from the front and above (viewing angle with respect to the geometry x-axis is 90 degrees, and viewing angle is approximately 20 degrees above the geometry y-axis).

### 7.5.2 Front View Position

The front view position displays the scene in exact front view (i.e. the viewing angle with respect to the geometry x-axis is 90 degrees and with the geometry y-axis is zero). This position (shown in Figure 7.9) helps in rotating the scene easily to the required angle.

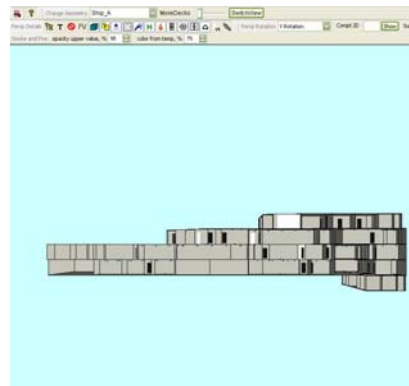


Figure 7.9 Front View Position

## **7.6 Tour Button**

The *Tour* button is an experimental feature which performs some preprogrammed 3D model zooming and rotation. It could possibly be enhanced in the future to allow user programmable paths to be specified and replayed to give a “fly thru” effect for the model, allowing the user to start, stop, change direction, change camera viewing angle and change zoom speed. We welcome comments on this feature.

## 8.0 FIRE SIMULATION TOOL

In addition to compartments, a ship has active elements or objects like junctions (doors, hatches, scuttles), suppression systems, ventilation fans and bulkheads, whose states can be changed for a simulation. Creation of a new simulation begins with setting the states of the ship's active objects, setting simulation parameters (e.g. duration of the simulation and ambient environment parameters) and fire propagation parameters (e.g. number of fire sources and their strength) through the GUI. An input file is created and

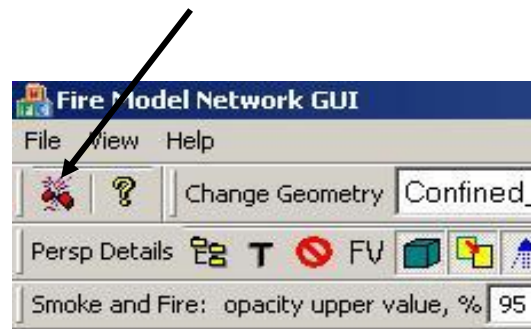


Figure 8.1 Fire Simulation Tool Location

passed to the network model which produces an output file. This output file is read by the GUI while it is being written by the network model and the results are visualized. Refer to Section 8.2.4 for details on how to share simulation data with another user.

By clicking on the Fire Simulation Tool (Figure 8.1), two new dialog windows pop up: the Object State Editor Dialog and the Fire Simulation Dialog as shown in Figure 8.2. One can move the pop up dialogs by dragging them to the desired location.

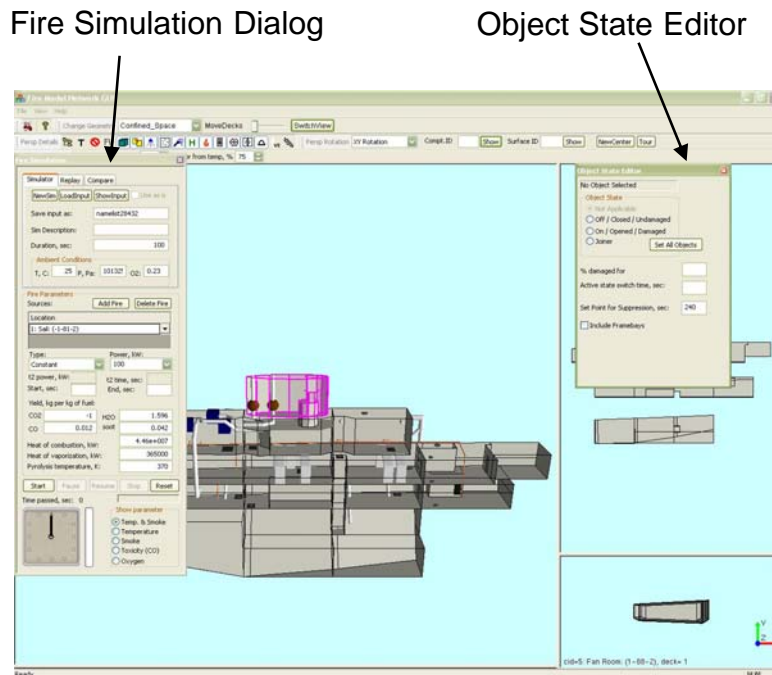


Figure 8.2 Fire Simulation and Object State Editor Popups

## 8.1 Object State Editor

Each active object may be in several different states (shown in Figure 8.3) depending on its type. An opening can be either in an *off* (or *closed* or *undamaged*) state or an *on* (or *opened* or *damaged*) state. A door has another special state called *Joiner* (refer Section 9.5). Using the state editor dialog, the user can set the state of any active object. Some objects' initial state at simulation start time persists throughout the entire simulation (e.g. junctions) whereas others' state may be changed by the simulator (e.g. fans or suppression systems turning on or off) during the run.

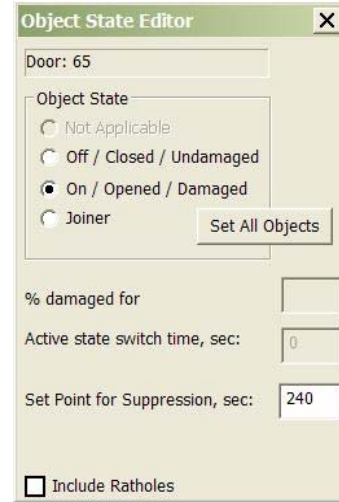


Figure 8.3 Object State Editor Dialog

To select an active object, click the left mouse button on the object (or place the mouse pointer on the object, press and hold SHIFT key and click right mouse button). The selection is confirmed by the changed name and ID in the top field in the Object State Editor dialog box. Once the object is selected, select the state by clicking on one of the options provided. Note that since the floor plan view does not show any active objects, they have to be selected only from the 3D view.

The change of state is visualized by a change in object color. In general, a light color corresponds to an *on/open/damaged* state and a dark color to an *off/closed/undamaged* state. For example, an open door is white, a closed door is black. An open damper is yellow, and a closed damper is brown.

### 8.1.1 Doors, Hatches, and Scuttles

Doors, hatches, and scuttles can be set to closed, or opened. In Figure 8.3, door 65 has been selected and set to open. Joiner state (refer Section 9.5) is applicable only to doors.

After any door, hatch, or scuttle is selected, choosing opened or closed, and clicking the *set all objects* button will set all objects of that type to that state. For example, clicking any hatch, then choosing opened, and clicking the *set all objects* button will set all hatches to opened.

### 8.1.2 Ventilation System

The ventilation nodes like fans and dampers can be turned on or off. The network model does not allow changing of states during runtime. However, a delayed change of status can be declared prior to the model execution using *Active State Switch Time* text box. For




example, in Figure 8.4, the ventilation node 118 (fan) is scheduled to change its status from on to off after 60 seconds of simulation time. The change of state always means a transition from one state to the opposite: e.g. from open to closed or from off to on. The Switch Time is ignored by the network model for junctions and surfaces.

### 8.1.3 Suppression System

Suppression nozzles are turned on only by the network model and so their states cannot be set by the user. A text box is provided for changing the set point for the suppression system. Set point is the time only after which the suppression gets activated. The default value is 240 seconds for Ship\_A model. Model turns on the suppression system individually for each compartment. Conditions of preset temperature and preset time should be satisfied for the suppression system to turn on.

### 8.1.4 Surfaces

A surface (bulkhead/wall) can have a state of damaged or undamaged. Surfaces cannot be selected from the 3D scene; they can only be selected from the compartment panel (bottom right panel). To select a surface, first select the compartment that contains the surface. Rotate the compartment in the panel so that the surface is facing the user. Then click the left mouse button on the surface in the compartment panel to select that surface. You can also select by right clicking while keeping SHIFT key depressed. The selected surface is shown in green color in the compartment panel. The surface id is shown in the Object State Editor dialog. Change the state to *On/Opened/Damaged* and give the percentage area of the damage in the text box. To see the damaged surface shown in blue color in the 3D scene (not the compartment subpanel) turn on the Damaged Surfaces

button  (Section 9.9). Note that even though the front surface(s) are transparent, you will be selecting them rather than the back surface(s). To select a back surface, rotate the compartment until the back surface is facing you. For an interior surface, zoom in enough that you pass the front surface.

### 8.1.5 Ratholes and Framebays

De-Watering Ratholes in Ship\_A or Framebays in Confined\_Space can be included or excluded in the simulation using two check boxes on the Object State Editor. The checkboxes are shown only if the geometry has the corresponding feature as shown in Figure 8.5 for Ship\_A. For more information on ratholes and framebays, see Section 9.7 and Section

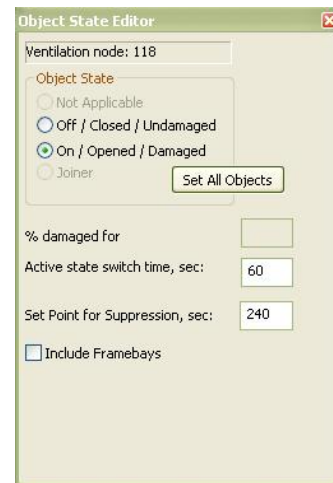


Figure 8.4 Ventilation Node Settings



Figure 8.5 Ratholes Checkbox



9.3 respectively. All the ratholes act as a single unit. Therefore, changing the state for individual ratholes is disabled. All ratholes are shown in white color when included. Including or excluding Framebays does not provide any visual effects.

## 8.2 Fire Simulation Dialog

The fire simulation dialog box shown in Figure 8.6 is used to set the simulation parameters. It has three tabs: *Simulator*, *Replay*, and *Compare* which are described further in the next sections. Note: If you do not see the entire dialog box as shown here (i.e. if the bottom is cut off), then increase the screen resolution (refer Section 2.0). You may also try hiding the Windows task bar which would give a little more screen space at the bottom for the dialog box.

Simulation parameters include name of the input file created for the particular run and a simulation description, the requested duration of the simulation, external conditions (ambient temperature and pressure), initial concentration of oxygen (assumed to be constant throughout the entire ship), and fire sources. The description and name of the input file are used for identification of the simulation for subsequent replay or comparison.

The simulation is executed by *Start*, *Pause*, *Resume*, and *Stop* buttons. The *Reset* button resets the visualization of simulation results in the GUI.

### Fire Sources

The controls in the central part of the GUI allow defining the fire source(s). Each fire source has a unique set of parameters that include location (to be selected from a drop-down list), fire type (constant,  $t^2$  fire, and *usetype*), power or speed (depending on which fire type was selected), starting and ending times, fuel parameters and others. Note that a *usetype* fire uses the fuel loading present in the compartment and therefore does not have a subtype. By default, a fire source is constant in time with a power of 100 KWatts. Figure 8.6 shows a  $t^2$  fire that is of ultrafast subtype.

A simulation can have several fire sources, each of which may have different settings. A new fire source is created by clicking the *Add Fire* button and can be removed by using the *Delete Fire* button. The *Add Fire* Button by default will create a fire source in the first compartment in the database, after which the user may select the desired compartment

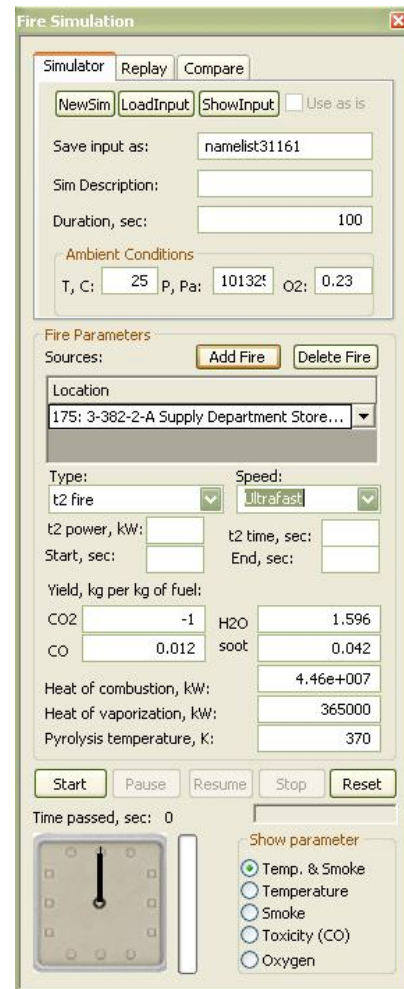


Figure 8.6 Fire Simulation Popup

from the drop-down list and set the fire parameters for this fire source. In order to select from the drop-down list, sometimes it is easier if you know the compartment id which can be obtained in several ways. From the 3D view, one can left mouse click in the compartment (but not on an active object) and see the compartment's id in the first field of the object state editor (refer Section 8.1). Also by clicking in the Floor Plan view

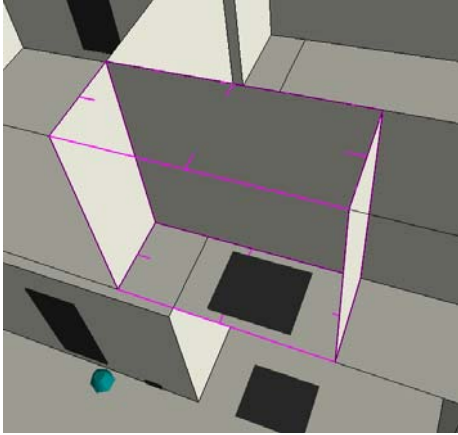


Figure 8.7 Fire Source Highlighting

(refer Section 13.0), the compartment will be highlighted and its id shown in the compartment panel (refer Section 13.3) and in the Compt. ID text box (refer Section 9.10). Any compartment which contains a fire source is outlined with pink color edges by default and small tick marks extending into the compartment as shown in Figure 8.7. The tick marks enable a user to know whether or not a given compartment is on fire when totally surrounded by other compartments which are on fire. In other words, even if the compartment has pink edges but no tick marks point into it, then it is not on fire. During a fire simulation run, a compartment which initially is not on fire can catch on fire. In that case, it is shown with pink edges.

Also, fire in a compartment may be extinguished by the suppression system in which case the pink edges are not shown. Thus apart from the propagation of heat and smoke, we can also see the propagation of fire from one compartment to another.

### 8.2.1 Running a simulation (Simulator tab)

Information from several different sources (the ship geometry stored in the database, the simulation parameters, and the state of the active objects from the GUI) is used to generate an input file (i.e. Fortran namelist file) for the network model.

The *NewSim* button opens a new simulation run and resets the current settings to their default values. The *LoadInput* button is used to load an input file. The *ShowInput* button generates the input file and opens it in notepad. This feature can be used for debugging purposes. The data fields (e.g. Save input as, Duration) have default values. The *Simulation Description* default value is the name of the input file if no description is given by the user. Ambient conditions such as temperature ( $T$ ), pressure ( $P$ ), and oxygen ( $O_2$ ) also have default values and can be changed by the user.

Instead of creating an input file from scratch, the *LoadInput* button can be used to load an existing input file to get the simulation settings used in that file. When the *LoadInput* button is clicked, the Available Inputs dialog (as shown in Figure 8.8) is opened with a list of available input files. After the desired file is selected from the list and the *Load* button is clicked, the fire sources, simulation parameters like duration, and states of the

active elements are loaded into the GUI and can be changed by the user thereafter. **If it is desirable to keep the original file unchanged, the “Save Input As” field should be changed to a new user supplied name. Otherwise, the original file would be overwritten whenever the *ShowInput* or the *Start* button is pressed.** A warning popup appears to remind you that the file is about to be overwritten.

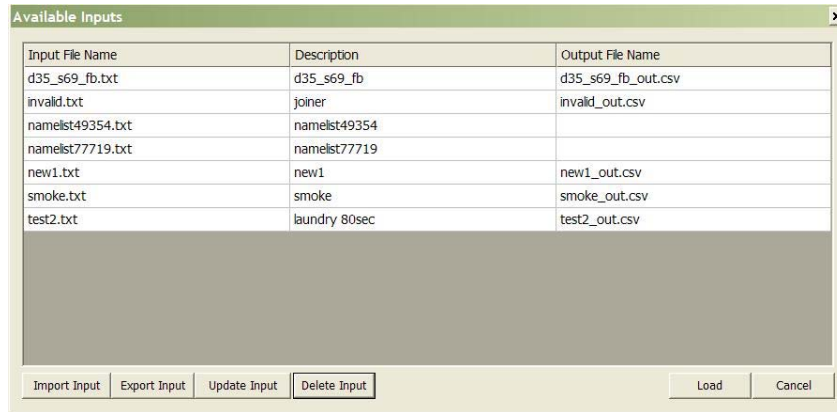


Figure 8.8 Available Inputs Dialog

Note: Only the parameters that were set from the FireGUI will be loaded from the existing file. The other required parameters will be read from the database before recreating the file. One exception to this is when the *Use as is* checkbox is checked.

In this case, the file is not overwritten or recreated, but submitted to the simulator without modification. Be aware that if you load an input file, change the settings and then check *Use as is*, your changes will be overwritten by the settings from the original file. Once the *Use as is* is checked, changing the simulation parameters or the active object settings is disabled. *Use as is* checkbox is only enabled after loading an input file.

The creation of the input file occurs **every** time the user clicks on the *Start* button or the *ShowInput* button and will overwrite any existing file having the same name unless *Use as is* is checked.

If the *Start* button was clicked, the status box located above the radio buttons is set to “Preparing ...” as shown in Figure 8.9. If incorrect data is entered (e.g. fire source not defined or duration is not an integer number), an error message box is shown and the status line is set to “Error...”

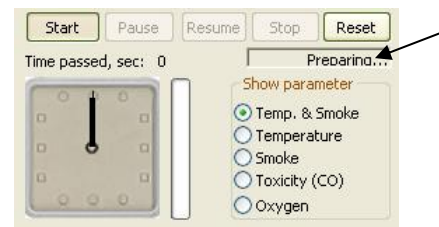


Figure 8.9 Status Box Location

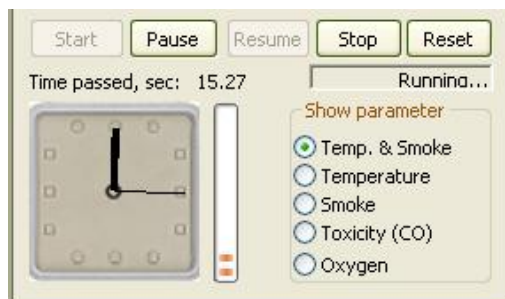


Figure 8.10 Simulation Running

After the file is successfully generated, the system starts the Network model and begins processing its output step by step. The simulation status in the status box is set to “Running..” and the simulation time is shown using an analog clock, a digital clock, as well as a progress bar as shown in Figure 8.10. The digital clock provides exact time; the analog clock makes it easy to compare the rate of

simulation with the real time, while the progress bar gives an estimate of how much time is left until the end of simulation. The user may pause or suspend this process, resume execution of a suspended simulation or stop it by clicking on the corresponding button. Results are visualized in both the 3D view and the floor plan view.

### Show parameter

The results of the simulation are displayed either by changing the color of the compartment surfaces (temperature, toxicity, and oxygen concentration) or by changing the opacity of the compartment (smoke) as shown in Figure 8.11. Consequently, it is not possible to see simultaneously the temperature and concentration of other parameters like oxygen. The buttons to right of the analog clock allow selecting the parameter to be displayed: temperature and smoke, temperature, smoke, toxicity, or oxygen. Note also that if surfaces are hidden you may not be able to see the temperature display (e.g., if a compartment has an elevated temperature but no smoke, then the temperature display may not be visible until surfaces are displayed again).

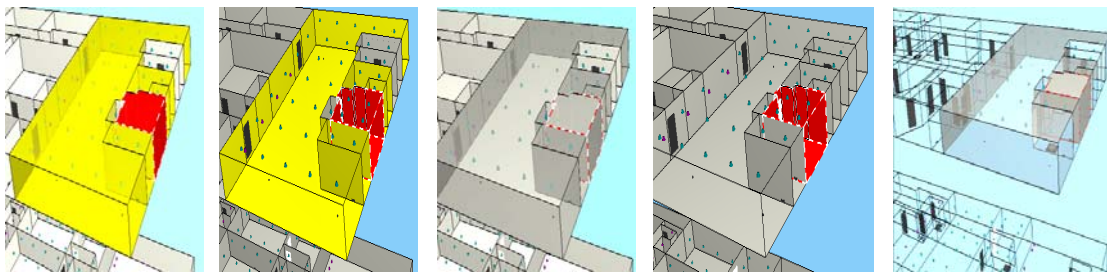


Figure 8.11 From left to right: Temperature and Smoke, Temperature only, Smoke only, Oxygen depletion, and Smoke only with bulkheads hidden

### Suppression System Activation

The network model is a one-zone model, i.e. it produces only one value per compartment. Therefore, the suppression system is either activated or not activated for the whole compartment. Thus, a compartment with suppression activated is visualized with a white dashed edge. If that compartment is also the fire source location, it is displayed with a red and white dashed edge; otherwise, with a black and white dashed edge as shown in Figure 8.12 below.

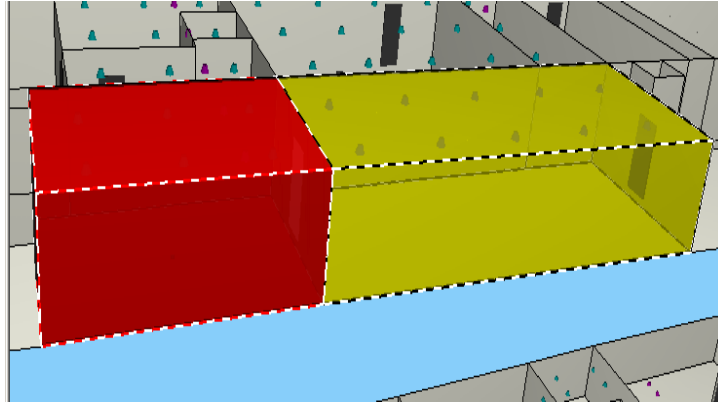


Figure 8.12 Suppression System Activation

Note that we need to run simulations beyond the set point time to see the activation of the suppression system (see section 8.1.3 for details).

### 8.2.2 Simulation Replay (Replay tab)

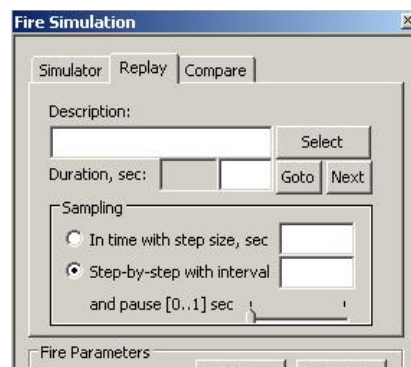


Figure 8.13 Replay Tab of the Fire Simulation Dialog

Since all simulations (both settings and results) are stored in the simulation repository, each simulation can be replayed at a later time by clicking the replay tab in the Fire Simulation Dialog as shown in Figure 8.13. In replaying, the results are read from an existing file and not generated in real time. To replay a simulation, the user must select from the list of available

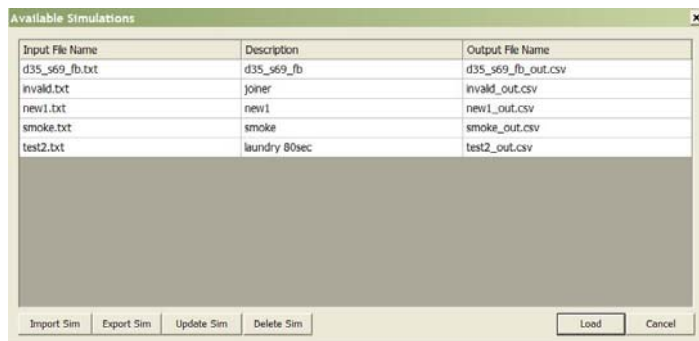


Figure 8.14 Available Simulations Dialog

simulations. Click on the *select* button, and the Available Simulations Dialog shown in Figure 8.14 will pop up, which contains the names of the input files and the descriptions of the simulations.

Select a simulation (by clicking on the name of the input file or description). The selected simulation becomes highlighted. Click on *Load* to confirm the selection or *Cancel* to close the dialog window without selecting a simulation. The remaining four buttons are explained in Section 8.2.4. Note that this dialog shows simulations that have both the input file and its associated simulation output file (.csv) files. Thus, if an input file is created but not executed, it will not be shown in the available simulations.

After a simulation is chosen, the selected input file is read and the ship's active objects are set to the appropriate states. To start replaying, press the *Start* button. The functionality of the rest of the buttons is the same as described previously.

The replay tab also allows the user to control how the simulation is replayed. Replay (reading from a file) is much faster than real-time simulation. To slow down the replay, the user may request a delay (pause) between time steps. On the other hand, for very long simulations, the user may also request skipping time steps (e.g. displaying every tenth time step) making the replay even faster. Figure 8.15 points out the different options to control replay of a simulation.

The network model uses a variable time step during the simulation. While replaying, the user may select a constant rate of time steps (called time sampling which corresponds to a variable temporal rate) or a constant temporal rate (called step sampling with variable amount of time steps skipped).

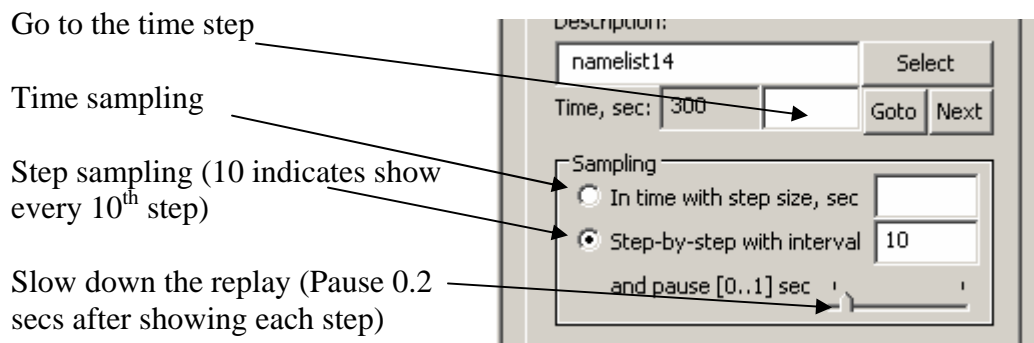


Figure 8.15 Various Components in the Replay Tab

The user may also skip the beginning of the simulation and jump directly to a specified simulation time by giving the time in the text box located to the left of the *Goto* button and clicking the *Goto* button. The *Next* button can be used to go to the next step.



### 8.2.3 Comparison of Two Simulations (Compare tab)

Comparison of two simulations is an extension of the replay mode to replay two simulations, simultaneously. When the *Compare* tab of the Fire Simulation dialog window is clicked (Figure 8.16), the panels are resized so that two panels with main view are shown each occupying half the screen.

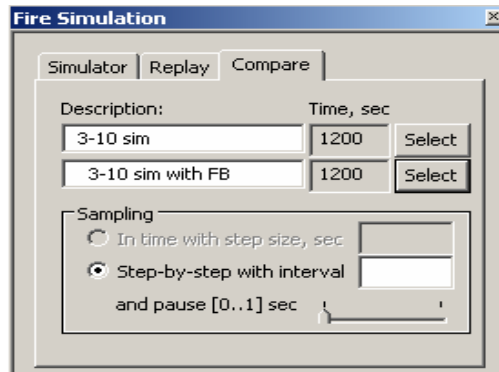


Figure 8.16 Compare Tab

Two previously run simulations are selected by clicking the two *Select* buttons or both runs can be selected simultaneously (use CTRL key to select multiple selections) from the same *Select* button. The simulations can be controlled in the same way as a simple replay (except that time sampling is disabled for comparisons). To see the fire parameters associated with each simulation, click in the description text box of that simulation; the fire location, type, power, etc. are displayed in their respective fields.

The simulations are replayed when the user clicks *start* button. Note that if two simulations have different durations, then the results are shown for the least duration (e.g. Sim1 runs for 100 sec and Sim2 run for 150 sec, then comparison is done only for the first 100 sec).

In compare mode, holding down the Ctrl key in conjunction with the normal mouse button actions (rotation, zooming, and translation) will simultaneously affect both compare panels rather than just the one the mouse is in.

Figure 8.17 and Figure 8.18 show comparison of previously run simulations in different views.

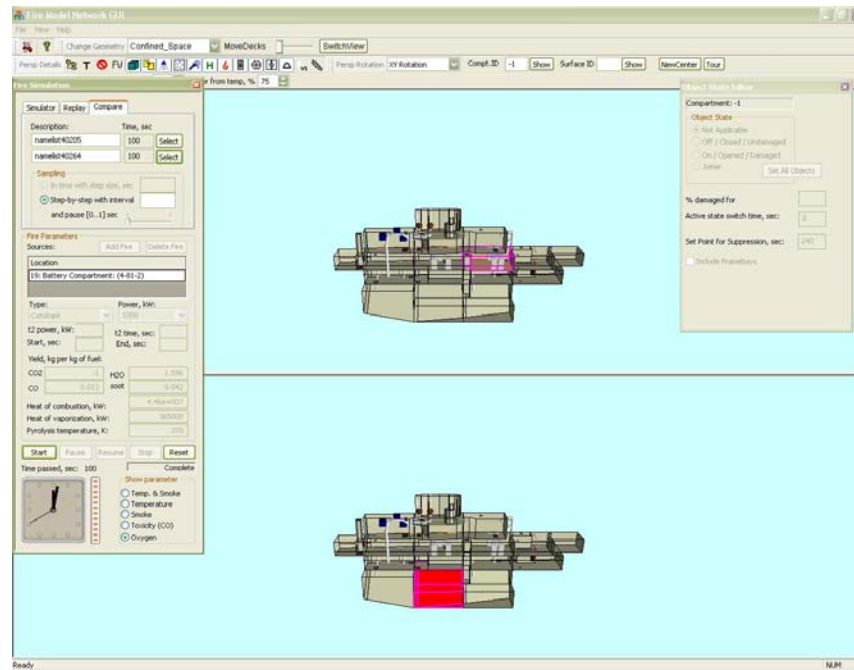


Figure 8.17 Comparison of Simulations in Confined\_Space (Above with Framebays not Included, Below with Framebays Included)

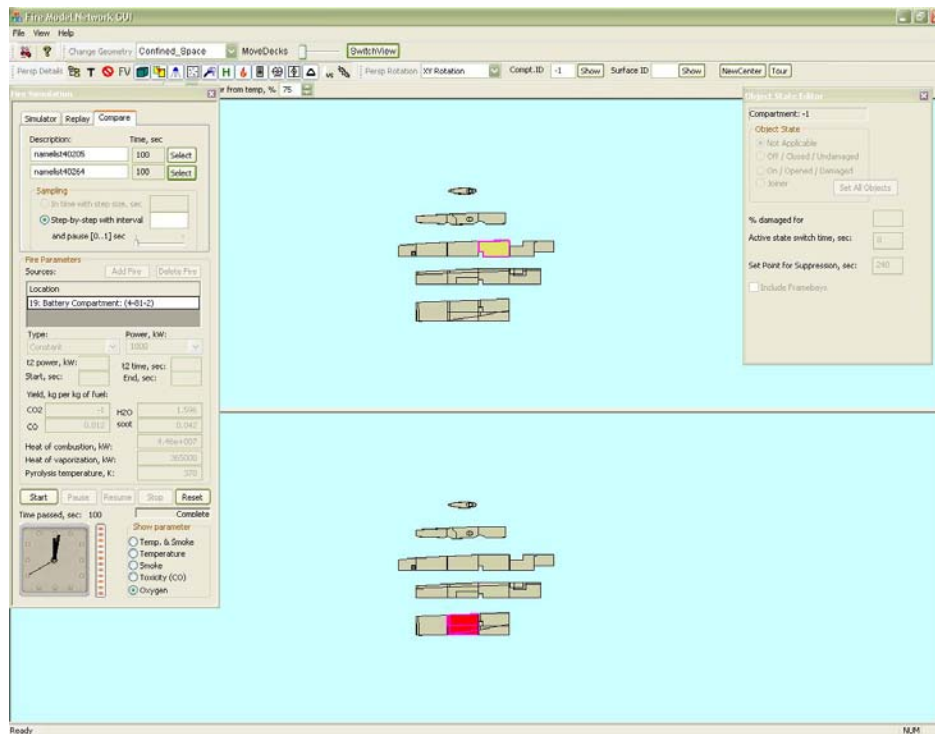


Figure 8.18 Comparison of Simulations in the Floor Plan View by Using the SwitchView Button for Confined\_Space.



## 8.2.4 Importing, Exporting, Renaming and Deleting Simulations

The popup Available Inputs (as shown in Figure 8.8) or Available Simulations (as shown in Figure 8.14) has buttons for importing (e.g., from another user), exporting, updating, or deleting file(s). Import and Export popup dialog boxes are shown in Figure 8.19. Inputs refer to only an input file, whereas Simulations refer to a pair of files – the input and the associated output file. These operations can be performed on multiple files simultaneously (selected using CTRL or SHIFT key on the keyboard). When importing an input file or simulation, or exporting to give to another user, **please note** that the geometry database should be the same or problems or even a crash of the software is possible.

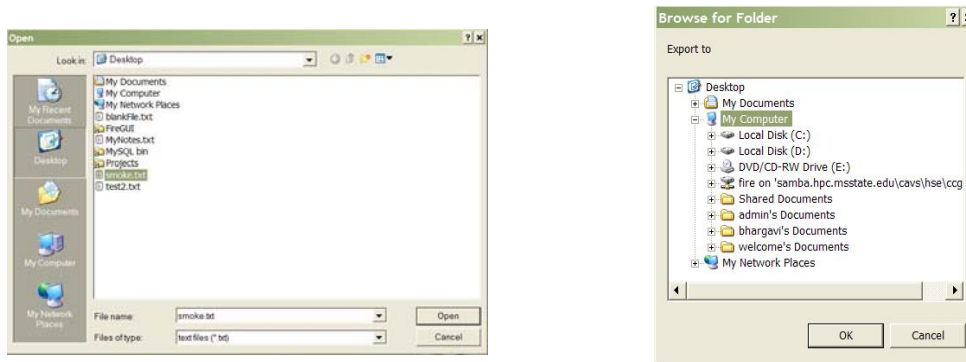


Figure 8.19 Import (Left) and Export (Right) Popups

For renaming, first double click on Name and/or Description column and change the text as required. Then keeping this row selected, click the *Update* button. If the name column is changed then both the input file name as well as the associated output file name are renamed. Note that changing just the output file name has no effect.

## 9.0 SHOW TOOLS

A ship or a building has subsystems (e.g. junctions and ventilation) apart from compartments and surfaces. A junction is referred to as any opening; therefore, doors, archways, scuttles, hatches, and ratholes are all different types of junctions. The subsystems for the example databases are as follows: Confined\_Space has doors, hatches, scuttles, firemain, and ventilation including framebays; Ship\_A has doors, hatches, scuttles, ratholes, and suppression; Building\_B has doors and stairs modeled as hatches. Shadwell\_Forward has doors, hatches, scuttles, firemain, ventilation, inert gas, and watermist systems but firemain, ventilation, inert gas, and watermist systems are excluded from simulations. Note that not all models (geometries) have all subsystems. When a model does not have a particular subsystem and the corresponding show tool button is clicked, no action is taken.

Using Show Tools (Figure 9.1) one can select different subsystems (details) to be shown or hidden. By default, all subsystems except virtual surfaces and damaged surfaces are shown, i.e. all Show Tools but two are turned on.

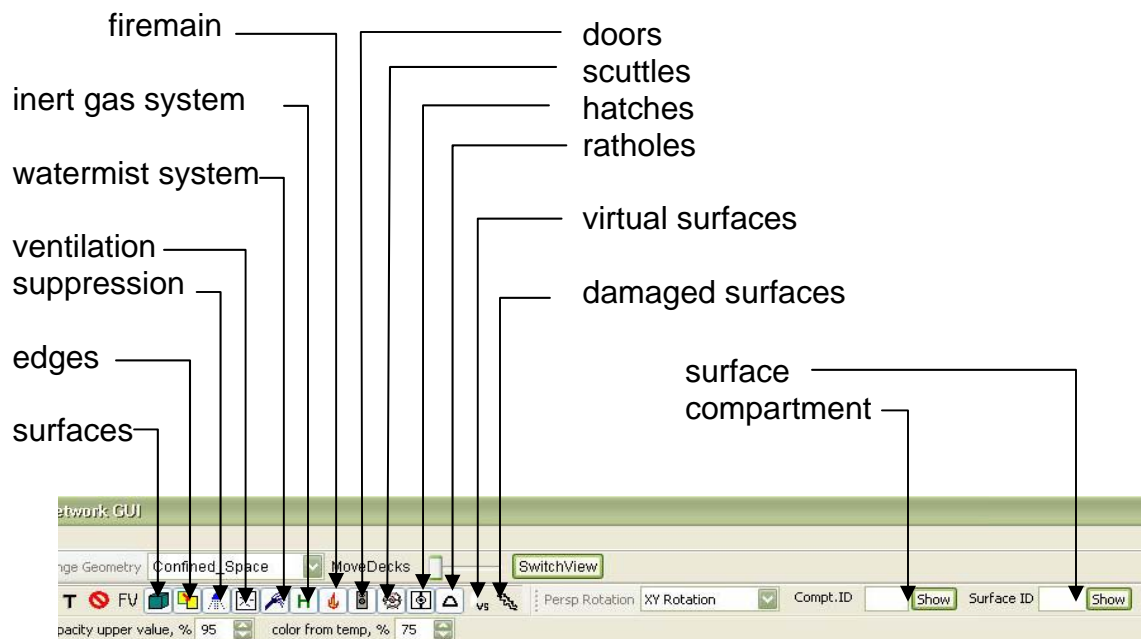


Figure 9.1 Show Tools

All buttons of the Show Tool act as toggles: consecutive clicks on the buttons switch the display of the corresponding subsystem on and off. A lighter gray background with a depressed look for the button indicates that the display is switched on, and a grey

background with a non-depressed look indicates that it is off. In the above picture, all buttons of the Show Tool except virtual surfaces and damaged surfaces are switched on.

## 9.1 Surfaces and Edges



Surfaces button



Edges button

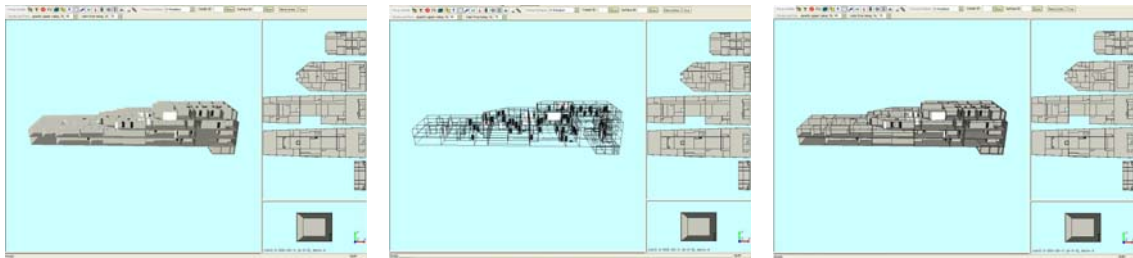


Figure 9.2 From Left to Right: Surfaces Only, Edges Only, Both Surfaces and Edges

In Figure 9.2, the left picture shows only surfaces (surfaces button turned on, edges button turned off), the middle one shows only the wire frame (surfaces button turned off, edges button turned on), and the right shows both (surfaces and edges buttons turned on).

## 9.2 Suppression System



Suppression system button

The suppression system button toggles the display of the nozzles (Figure 9.3).

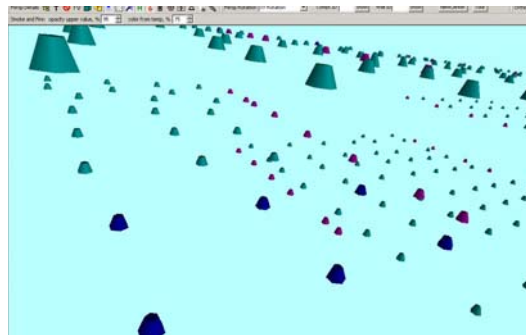


Figure 9.3 Suppression System Nozzles

The suppression system has three types of nozzles as shown in Figure 9.4.

1. AM-18 (sidewall nozzle used for Primary Damage Area cooling) type nozzle displayed as magenta cones
2. AM-11 (thermally actuated general Class A area light hazard suppression nozzle) type nozzle displayed as cyan cones
3. AM-4 (open machinery space nozzle, UL Listed for flammable liquid hazards) type nozzle displayed as blue cones

AM-4 type nozzle (open machinery space nozzle, UL Listed for flammable liquid hazards)

AM-11 type nozzle (thermally actuated general Class A area light hazard suppression nozzle)

AM-18 type nozzle (sidewall nozzle used for Primary Damage Area cooling)

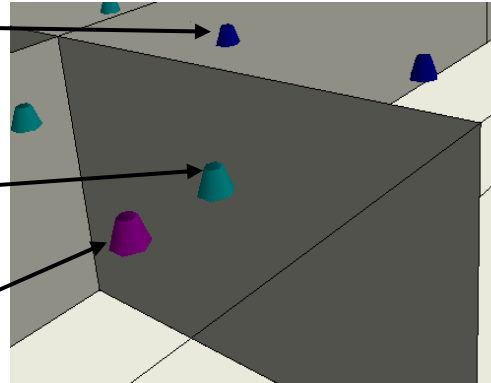


Figure 9.4 Different Types of Suppression Nozzles

When the suppression system is active for a compartment, the compartment is shown with white dashed edges. See Suppression System Activation in Section 8.2.1 for more details.

### 9.3 Ventilation System



Ventilation system button

Figure 9.5 below shows the ventilation system zoomed in. Fans are shown as blue cubes and dampers are shown as brown spheres. When a fan is on, it is shown in bright blue color and, when a damper is opened, it is shown in yellow. See Section 8.1 for setting the state on or off.

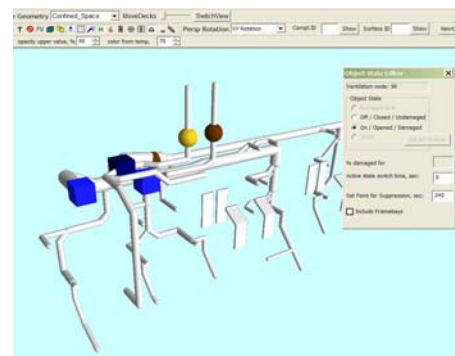
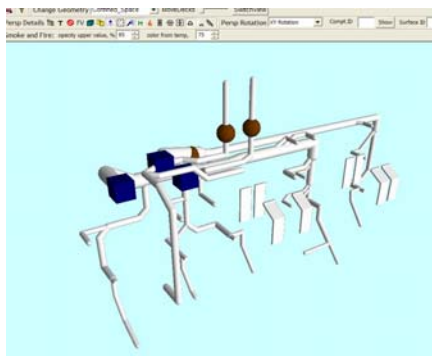


Figure 9.5 Left: Ventilation System; Right: Two Fans On and One Damper Opened

The ventilation system has Framebays which are a Confined\_Space specific feature. Framebays were added to the model to simulate openings between the decks and hull of a confined space through which heat, smoke, and other combustion products can travel. Framebays are displayed as vertical, flat, ventilation sections. For example, framebays connecting two compartments are shown in Figure 9.6. Refer Section 8.1.5 to know how to include or exclude the framebays from the simulation.

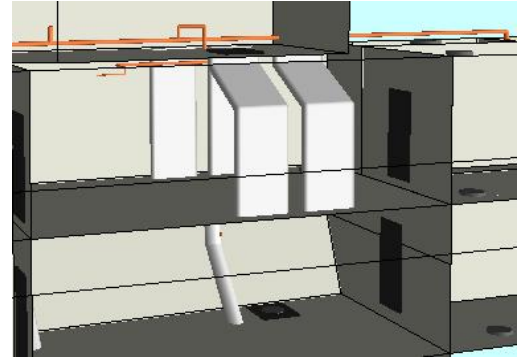


Figure 9.6 Ventilation System Framebays

## 9.4 Firemain, Watermist, and Inert Gas Systems



Firemain button



Watermist button



Inert gas button

Figure 9.7 below shows firemain system, watermist system and inert gas system.

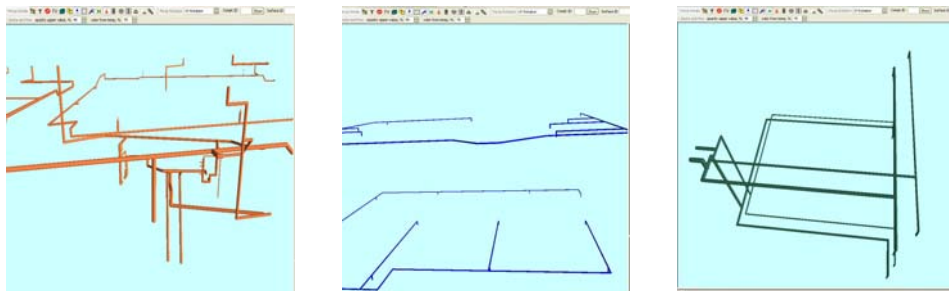


Figure 9.7 From Left to Right: Firemain system, Watermist System, and Inert gas System

## 9.5 Doors



The *Doors* button shows or hides doors and archways. Closed doors are represented in black color while opened doors are represented in white color as shown in Figure 9.8. A door can also be a Joiner; in which case, it is represented with a sphere in the middle. Joiner state is used for the Confined\_Space to simulate a closed door but with a vent grate that is always open (the joiner door). Archways are always open and cannot be closed. Section 8.1 describes how to change the state of a junction.

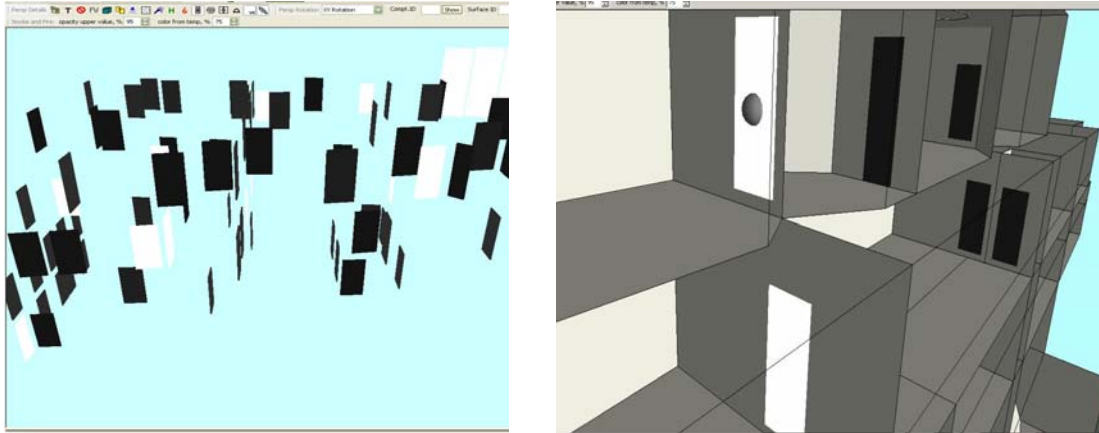


Figure 9.8 Left: Doors and Archways; Right: Upper Door set as Joiner and Lower Door as Opened

## 9.6 Scuttles and Hatches



Scuttles button



Hatches button

Scuttles are represented as circular disks and hatches as rectangular slabs as shown in Figure 9.9. They are black in color when closed and white when opened. Section 8.1 describes how to change the state of a junction.

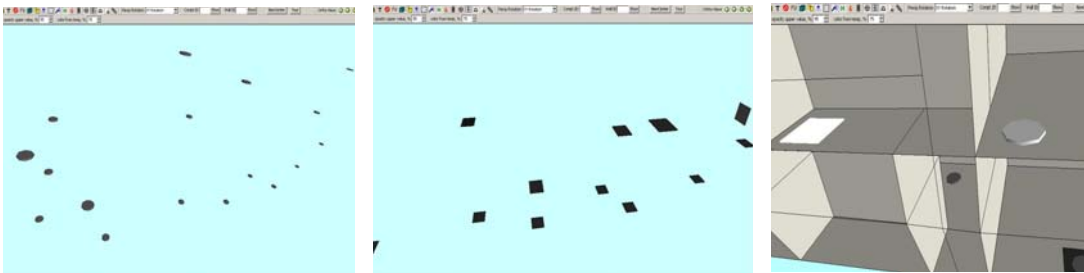


Figure 9.9 From Left to Right: Scuttles, Hatches, and Upper Hatch and Scuttle Opened

## 9.7 Ratholes



Ratholes button

Ratholes were added to the test area as shown in Figure 9.10 to facilitate draining of water due to activation of mist suppression.

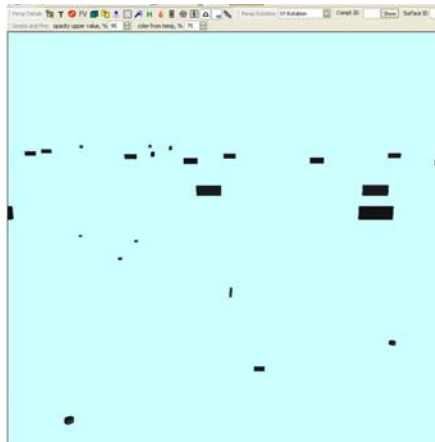


Figure 9.10 Ratholes

There are three types of ratholes shown in Figure 9.11:

1. De-Watering Type A ratholes that connect compartments of the same deck. These are displayed as cuboids.
2. De-Watering Type B ratholes that connect a compartment and environment. These are displayed as short cylinders.
3. De-Watering Type C ratholes that connect compartments of different decks. These are also displayed as short cylinders.

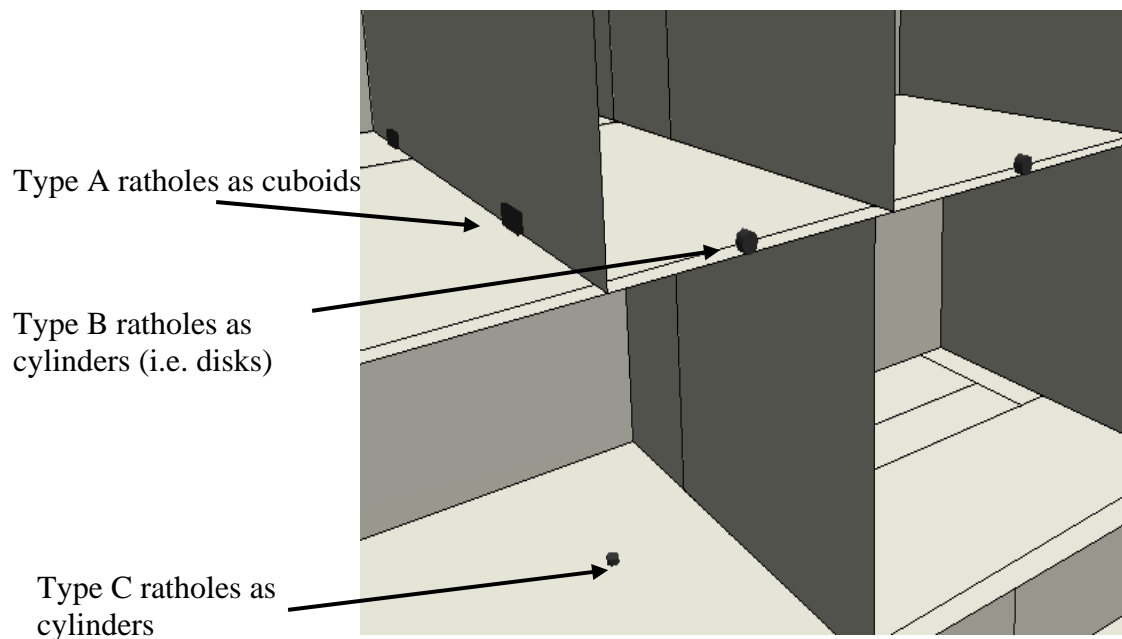


Figure 9.11 Types of Ratholes

Ratholes cannot be opened or closed individually. The “*Include Ratholes*” checkbox in the Object State Editor Dialog (refer Section 8.1.5) changes all the ratholes to be opened or closed. All ratholes are white in color when opened.

## 9.8 Virtual Surfaces



Virtual Surfaces button

Figure 9.12 below displays virtual surfaces (artificial bulkheads/walls) as white semi-transparent surfaces. These virtual surfaces were obtained from splitting some odd shaped compartments (mainly hallways) into sub-compartments connected through junctions to aid the network model. The splitting was done in CAD files before the geometry extraction and the virtual surfaces cannot be changed by the FSSIM GUI user.

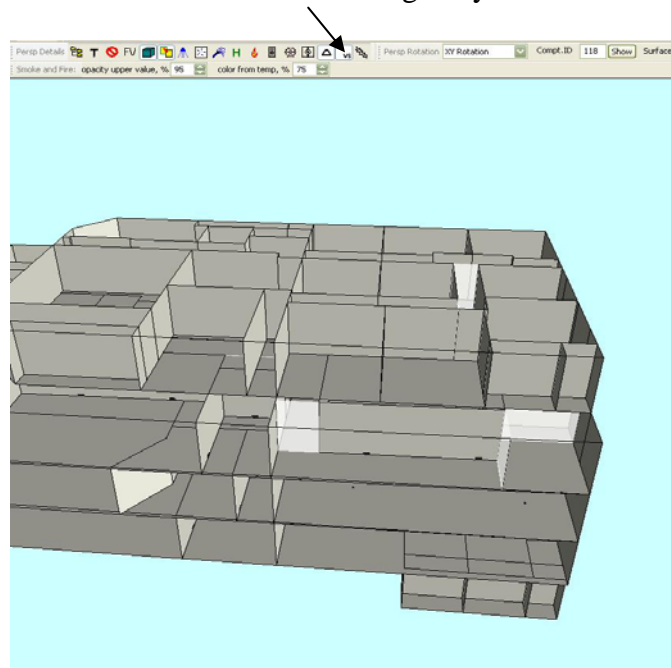


Figure 9.12 Virtual Surfaces

## 9.9 Damaged Surfaces



The *Damaged surfaces* button highlights the damaged surfaces in blue color as shown in Figure 9.13. Section 8.1 describes how to set the surfaces to be damaged.

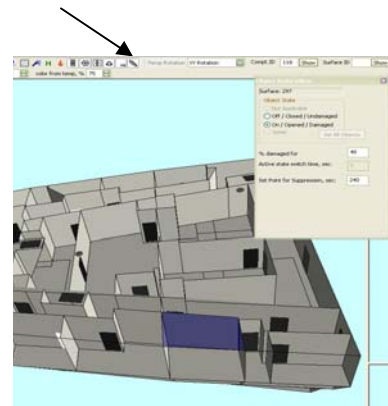


Figure 9.13 Damaged Surface



## 9.10 Show Compartment Tool

When the compartment number or id is provided in the text box and the *Show* button is pressed, the selected compartment is highlighted in the 3D view and in the floor plan view. The compartment is also shown in the compartment panel and the id is shown in the Object State Editor (refer Section 8.1). If the compartment tree browser (refer Section 10.0) is open, the compartment node in the tree is also highlighted. Show compartment tool has the same effect as clicking on a compartment in the floor plan or in the 3D view. Figure 9.14 below illustrates this feature. To deselect the highlighted compartment, clear the text box or enter -1 for the compartment number and click the *show* button.

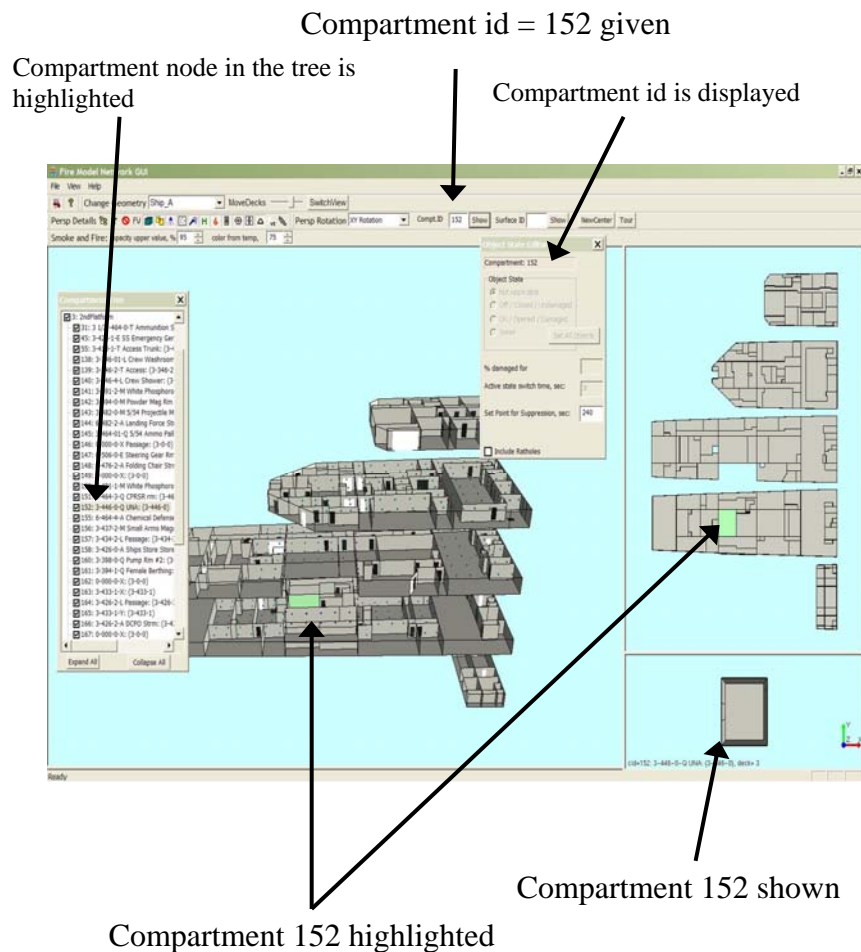


Figure 9.14 Illustration of Show Compartment Tool Feature

## 9.11 Show Surface Tool



The surface is highlighted in the 3D view when the surface id is provided in the text box and the *Show* button is pressed. Note that the *damaged surfaces* button is automatically turned on when Show button is pressed. In Figure 9.15 below, you see two surfaces highlighted to show the horizontal surface 885 because the decks are separated; therefore, the floor of the upper deck and the ceiling of the lower deck are highlighted. A vertical surface would only appear as a single highlighted surface.

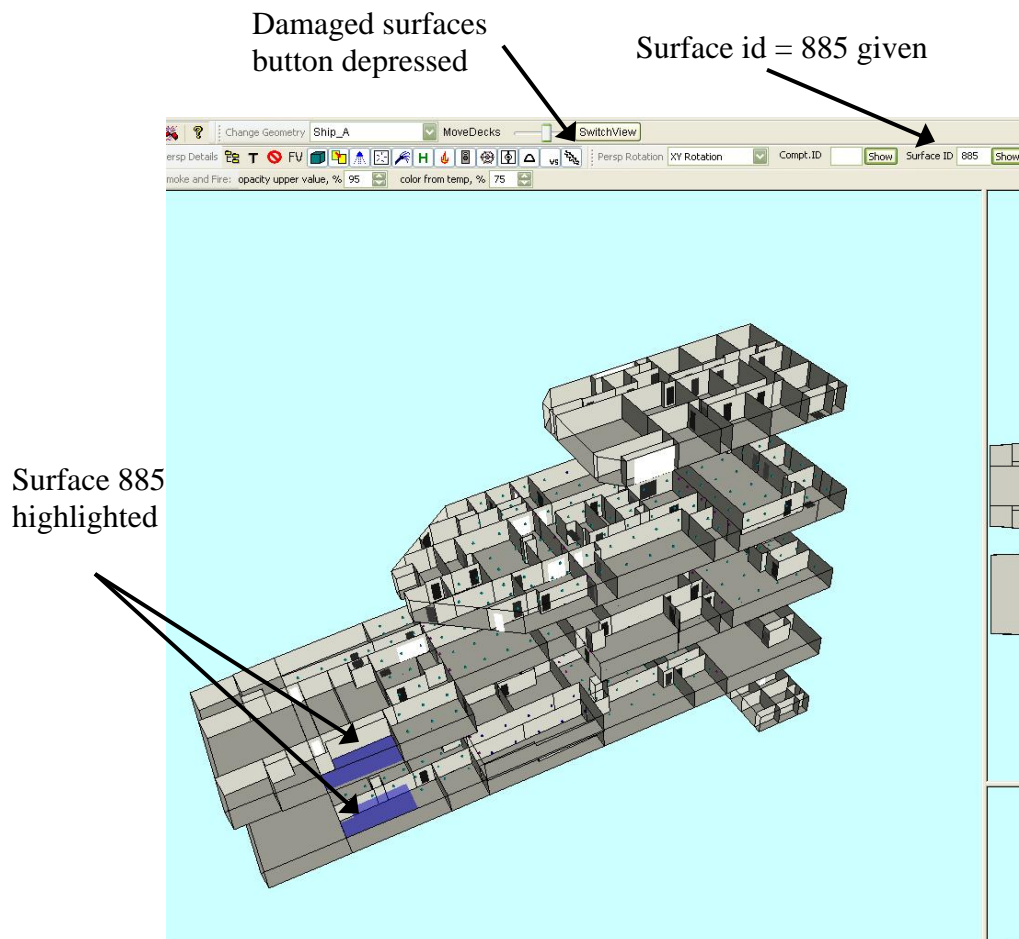


Figure 9.15 Functioning of Show Surfaces Tool

## 10.0 COMPARTMENT TREE BROWSER

By clicking on the *Compartment Tree Browser* button



, shown in Figure 10.1, a new dialog window (shown in Figure 10.2) pops up showing the list of compartments arranged by decks. Using this dialog, the user can select any compartments or decks to be displayed or hidden. Only checked elements are displayed in the 3D view and in the floor plan view; by default, all elements except the closed deck element (external surfaces) are checked.

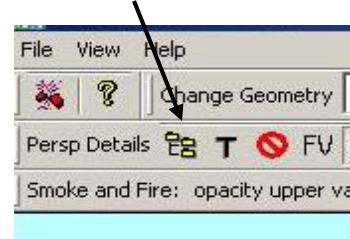


Figure 10.1 Compartment Tree Browser Button Location



Figure 10.2 Compartment Tree Browser Dialog

The *Expand All* button expands the tree completely and the *Collapse All* button collapses the tree to show only the deck names. Double clicking on any deck node expands that deck node to show all the nodes (compartments) under it as shown in Figure 10.2 on the left side.

Any combination of compartments or entire decks can be selected or deselected using the check boxes. For example, in Figure 10.3 below, for Ship\_A only deck no. 2 is checked in the tree and both 3D view and floor plan view show only deck no. 2.

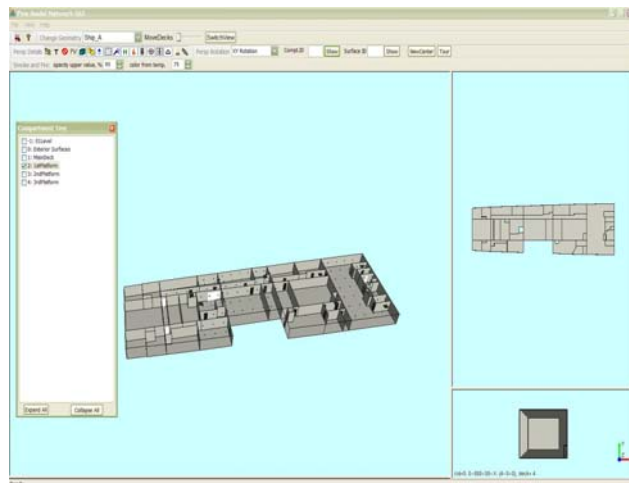


Figure 10.3 Only Deck No. 2 Selected

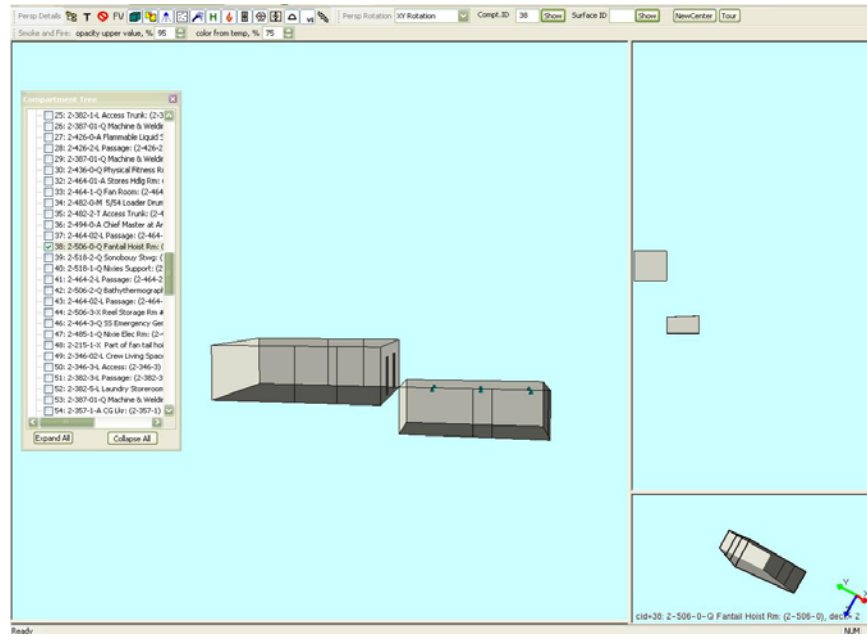


Figure 10.4 Compartment Selection

In Figure 10.4 above, 2 compartments (144 in deck 2<sup>nd</sup> platform and 38 in deck 1<sup>st</sup> platform) are selected.

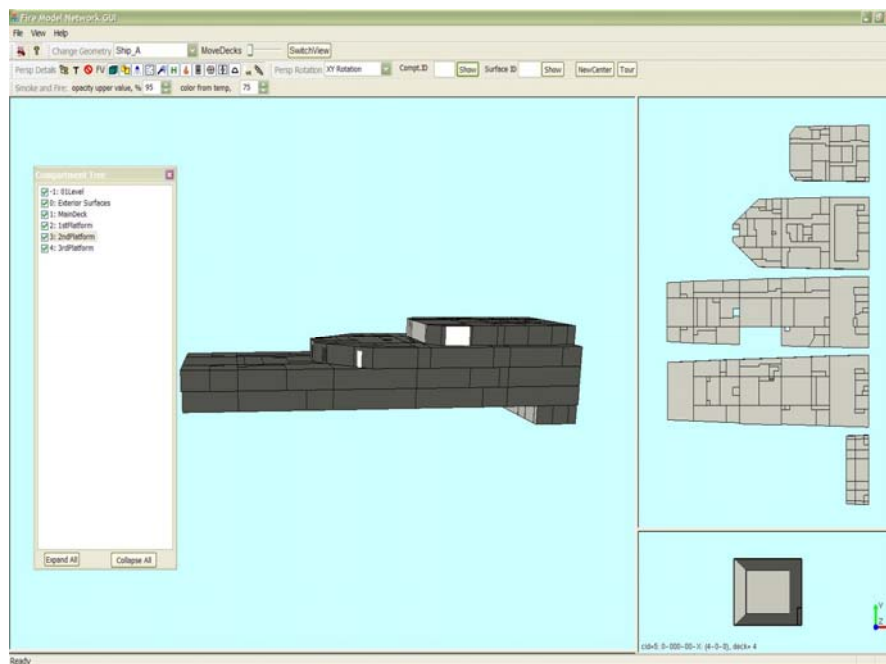


Figure 10.5 Exterior Surfaces Selection

By selecting the *Exterior Surfaces* checkbox, the exterior surfaces of the ship are displayed (Figure 10.5). Normally these surfaces are shown as transparent and only the edges of the surfaces are shown so the user can view the interior of the compartments.

If you click on the compartment label of a node (not the checkbox) in the tree, the compartment is updated in the compartment panel, highlighted in green color in 3D panel and floor panel, and the id is displayed in the Show compartment text box (refer Section 9.10).

### 10.1 NewCenter Button

When only a few compartments are displayed and the user rotates the scene, the compartments revolve around the geometric center of the entire ship instead of rotating around the displayed compartments. If the only compartments displayed are located far from the center of the ship and rotation about their geometric center is desired, the *NewCenter* button as shown in Figure 10.6 can be used.

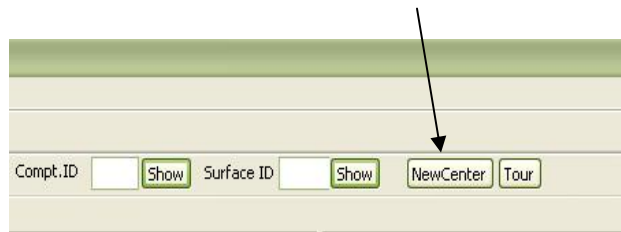


Figure 10.6 New Center Button Location

The *NewCenter* button computes a new geometric center which is an average of all the centers of the displayed compartments. The rotational center of the entire geometry can be restored when the *NewCenter* button is clicked while displaying the entire geometry.

## 11.0 LEGEND TOOL

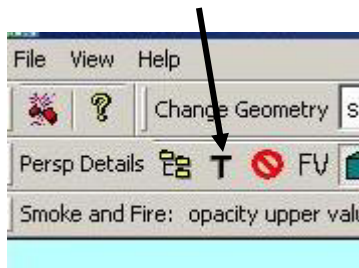


Figure 11.1 Legend Tool Button Location

The Color Map Legend tool (Figure 11.1) displays the legend for color mapping of temperature, visibility, toxicity, or oxygen. Only one parameter is shown at a time with the exception of temperature and visibility which can be shown simultaneously. To select a parameter, click on the drop down list and choose from the list. If the legend dialog box is open and the user changes the show parameter using the buttons to right of the analog clock in the Fire Simulation dialog, the legend is updated to reflect the displayed parameter. The visibility legend shows a white vertical bar in the middle which disappears as the visibility decreases (observed toward the top of the legend).

Figure 11.2 below shows the legend for Temperature and Visibility.

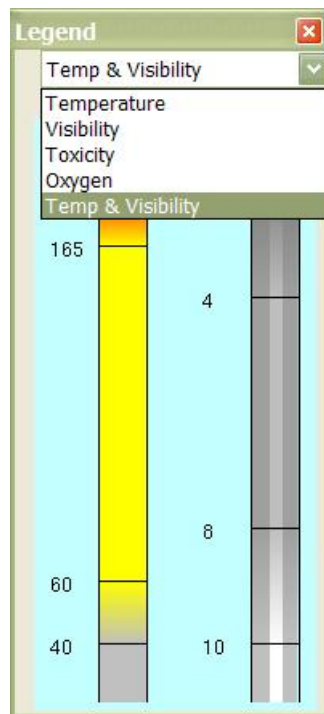


Figure 11.2 Legend for Temperature and Visibility

## 12.0 MENUS

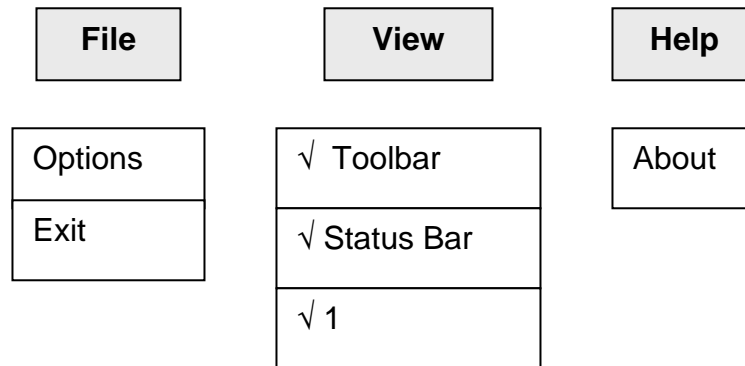


Figure 12.1 Menus

There are three menus: File, View, and Help as shown in Figure 12.1.

### 12.1 File Menu

*Options* lets the user change color schemes (discussed in Section 12.1.2 )

*Exit* exits the application.

#### 12.1.1 Options.xml File

The application uses several options that are stored in an xml file called ‘options.xml’ which is located in the same directory as the application executable. When the application is initialized, ‘options.xml’ is read and the values are used. If the ‘options.xml’ file is not found, the application creates it with default values. This xml file contains information about color maps, background and surface colors, simulation results directory location, input (namelist) file extension, and name of the database configuration file (i.e., file containing the list of databases). These values can be changed by editing the xml file manually. The name of the database configuration file defaults to ‘dbconfig.txt’ and contains the names which appear in the drop-down list of the *Database Selection* dialog box at application startup and in the *Change Geometry* drop-down list at the top of the application window. The database names should match the installed database names.

#### 12.1.2 Options Menu

The Option submenu pops up a new tabbed frame (shown in Figure 12.2) that allows setting the color scheme for the GUI and color mappings for visualization of simulation results. When the File/Options menu is clicked, the values from the



Figure 12.2 Options Dialog

options.xml file are shown in the dialog. Whenever the user changes the color map or color settings and clicks OK, the options.xml is overwritten with the new values.

If the user wants to use another file instead of options.xml, it can be loaded by giving its location in the *LoadFile* text box and clicking the *LoadFile* button. If one does not want to overwrite the options.xml file, the changed values can be stored in another file specified in the *Save to file* text box and by clicking *OK*. The “*Reset to Defaults*” button resets all options to the default values with a step based color map as described in Section 12.1.3. The “*Default Linear Map*” button resets all options to the default values with a linear based color map as described in Section 12.1.3.

### 12.1.3 Color Mapping

Simulation results are visualized by mapping data values to colors (referred to as color mapping). The *Color Maps* tab allows one to modify the color map values and colors for four parameters: temperature, toxicity (carbon monoxide concentration), oxygen concentration, as well as opacity for smoke visualization.

For example the default color map for temperature is as follows:

- Below 40C (default units are Celsius C) -- no color is shown (only default compartment surface color) as the conditions do not impact activities of humans.
- Between 40C and 60C -- color intensity increases from default surface color to yellow, i.e. transition between a safe region and a region where humans need protective equipment.
- Between 60C and 165C -- color stays constant yellow. In this region the color does not show any differences to varying temperatures, as long as the values are in the range where humans with protective equipment are safe.
- Between 165C and 185C -- color goes from yellow to red (transition between the limited access and no access regions).
- Above 185C -- color remains at saturated red indicating uninhabitable areas for humans.

Toxicity and Oxygen are also shown by coloring the compartment surfaces. The loss of visibility due to smoke is visualized by opacity rather than color.

There are two methods to set the color map.

#### Method A:

1. First, choose the required parameter from the drop down list of *Select Parameter*.
2. Select the *Start Color* radio button and click on the spectrum to choose the start color.
3. Then, select the *End Color* radio button and click again on the spectrum to choose the end color.
4. The *Preview ColorMap* button can be used to preview the color map before applying it.
5. Click the OK button to overwrite the *options.xml*.



The Color Map is applied from start to end color in the spectrum. The *Number of colors* text field is updated with the number of colors that fall in the selected spectrum range. The range values for each color are assigned from predefined values. The color and range values for each color index can be changed by following steps 3 to 4 from Method B.

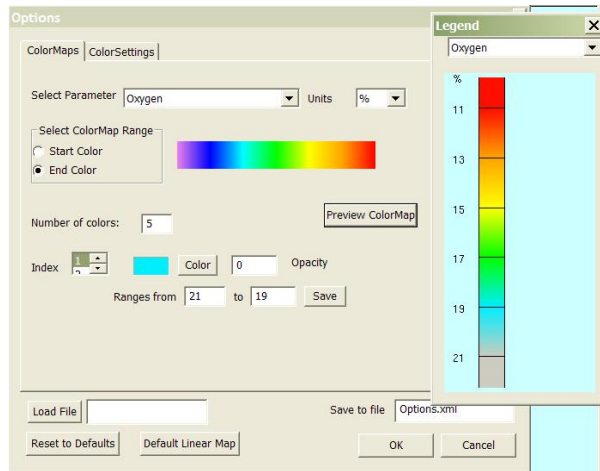


Figure 12.3 shows the color map preview for oxygen with start color as cyan and end color as red, selected from the spectrum. Five colors used in this example are: cyan, green, yellow, orange, and red.

Figure 12.3 Color Mapping

### Method B:

1. First, choose the required parameter from the drop down list of *Select Parameter* and choose the desired units.
2. Enter the number of colors (maximum allowed is 9).
3. Select each color index.
  - Click the *Color* button and choose the color from the popup
  - Select the range values. For Visibility, select opacity value between 0 and 1. (0 is transparent and 1 is opaque). Opacity field is ignored for Temperature, Toxicity, and Oxygen. Color is ignored for Visibility.
  - Click the *Save* button for the ranges to be saved.
4. Click the *OK* button to overwrite the options.xml.

**Note:** The range values for all the colors should be given in ascending or in descending order. Color mapping will not work if the ranges are given in a haphazard way.

### How color mapping is done:

The color starts at range1 and increases until range2, i.e. the color is at its full intensity at range2. For step mapping, give gaps between ranges (Figure 12.4). For linear mapping, give continuous ranges (Figure 12.5).

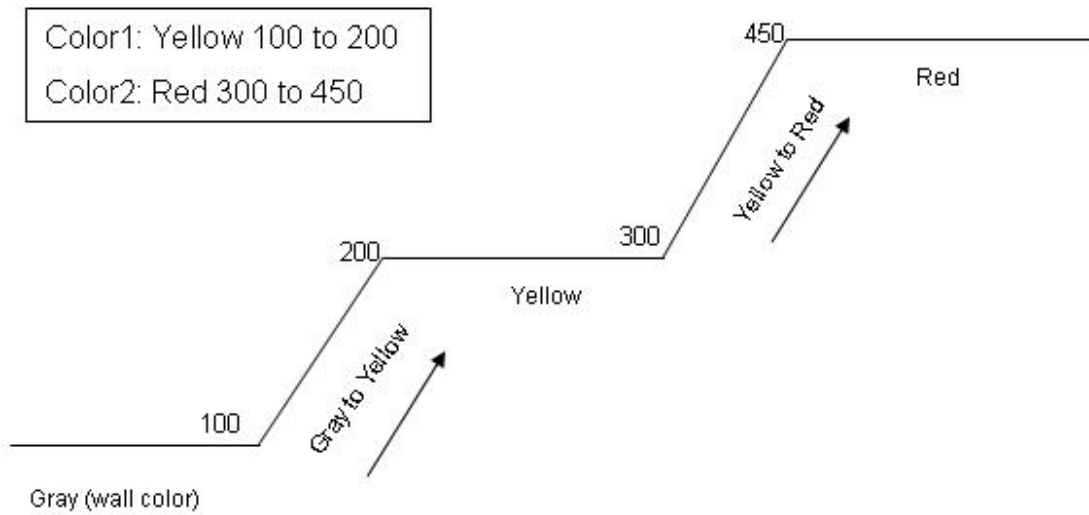


Figure 12.4 Step Color Mapping

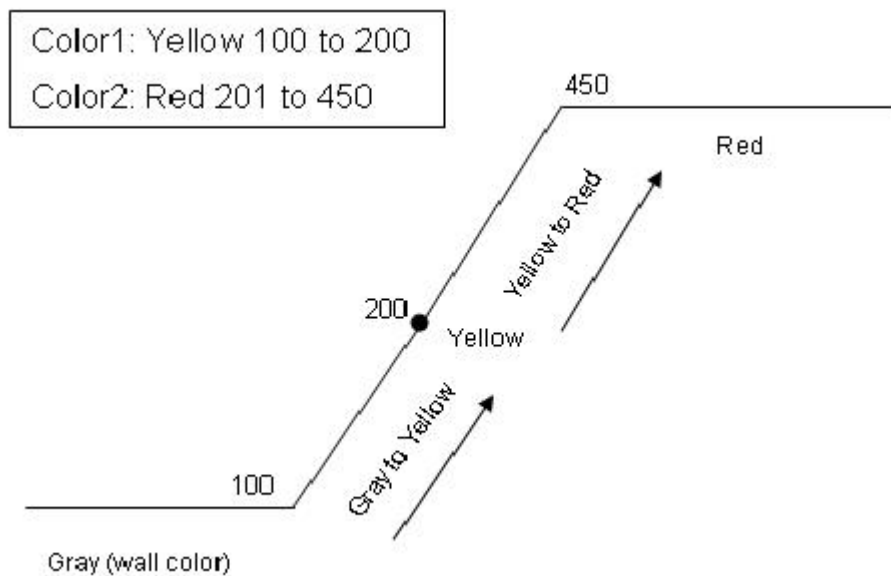


Figure 12.5 Linear Color Mapping

### 12.1.4 Color Settings

This *Color Settings* tab provides the capability for the user to modify the color of the GUI background, color of surfaces, and color of the fire source. The fire source color is used to outline the compartment that is on fire.

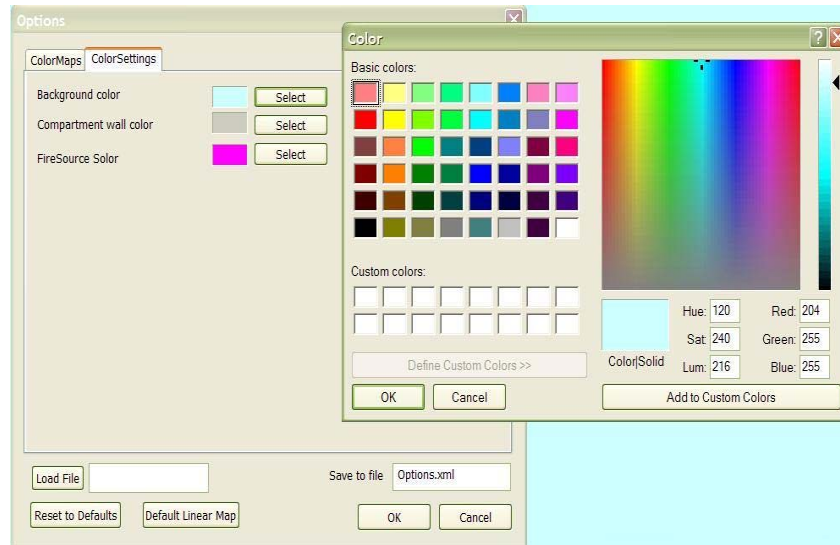


Figure 12.6 Color Setting Tab with Color Dialog Popped up

To change the color, click on the *Select* button and chose the color from the color dialog as shown in Figure 12.6. Click *OK* to save and close the options dialog.

## 12.2 View Menu

The Toolbar and Status Bar options allow hiding toolbars and/or Status bar (click on the menu option to toggle). The menu item “1” is not used.

## 12.3 Help Menu

The *About* menu displays the credentials of the application, version number, copyright information, contact information (Figure 12.7).



Figure 12.7 About Dialog

## 13.0 PANELS

The panels on the right side of the GUI provide additional views of the ship supplementing the 3D model display in the large main panel (Figure 13.1). Further details on each of the panels and views are available in the following sections.

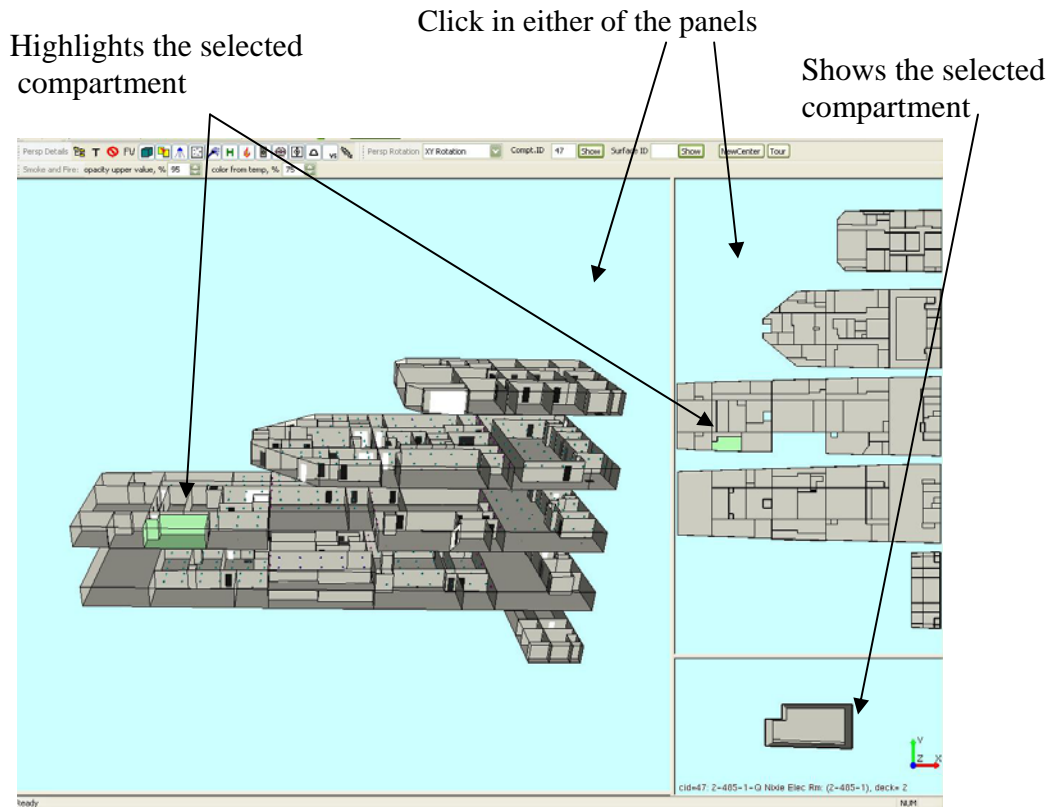


Figure 13.1 Different Panels

### 13.1 Main Panel

The Main panel displays by default the 3D model of the ship (Figure 13.2). The Main panel is the primary place where the results of the fire and smoke simulation are visualized. In addition, setting the state of the ship when displaying the 3D view is also performed in this panel (i.e. state of doors, hatches, and scuttles are set).

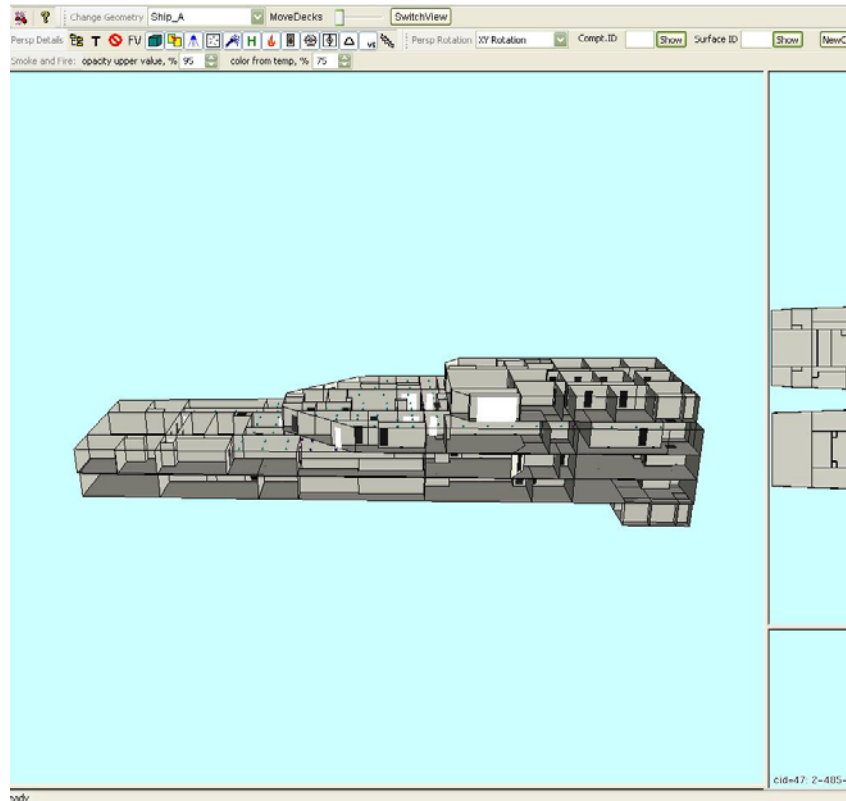


Figure 13.2 Main Panel

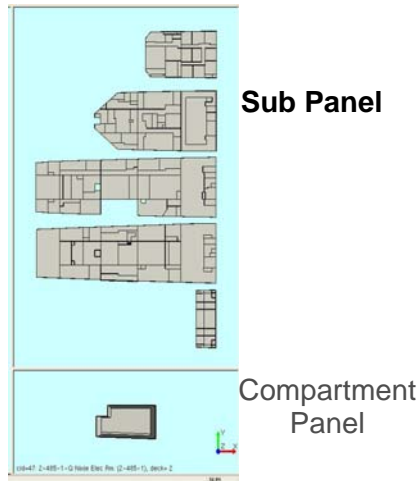
The 3D model can be rotated, zoomed in and out and moved inside the panel (refer Section 7.0). The view can be further customized by selecting particular fragments of the ship (refer Section 10.0), and particular ship subsystems (e.g. suppression and ventilation as described in Section 9.0).

Note that the front bulkheads that obstruct the view into the inside of the ship are removed. When the ship model is rotated 180 degrees, the front bulkheads become back ones, and vice versa. Therefore, the removal of the bulkheads is done on-the-fly, depending on the position of the ship. The external bulkheads can be restored using the Compartment Tree Browser (refer Section 10.0).

As mentioned in the *SwitchView* button section (Section 5.3), the Main Panel's 3D view may also be swapped with the Sub Panel's Floor Plan view described below.

## 13.2 Sub Panel

The Sub Panel (Figure 13.3) displays by default the Floor Plan view (similar to a blueprint) of a ship or building. This provides a convenient way to select an individual compartment for display in the Compartment panel and to be highlighted in both the Floor Plan and the 3D views.



This Floor Plan view allows zooming and moving by using the mouse; however, rotation is disabled, since a floor plan is designed to be viewed from the top and the left mouse button is used for picking a compartment. Simply click the left mouse button on a compartment to highlight and display it.

Figure 13.4 below illustrates zooming in and out of the floor plan view panel.

Figure 13.3 Sub Panel Location

If the Floor Plan view is selected to be viewed in the Main Panel via the SwitchView button, then the 3D view is displayed in the Sub Panel (refer Section 5.3).

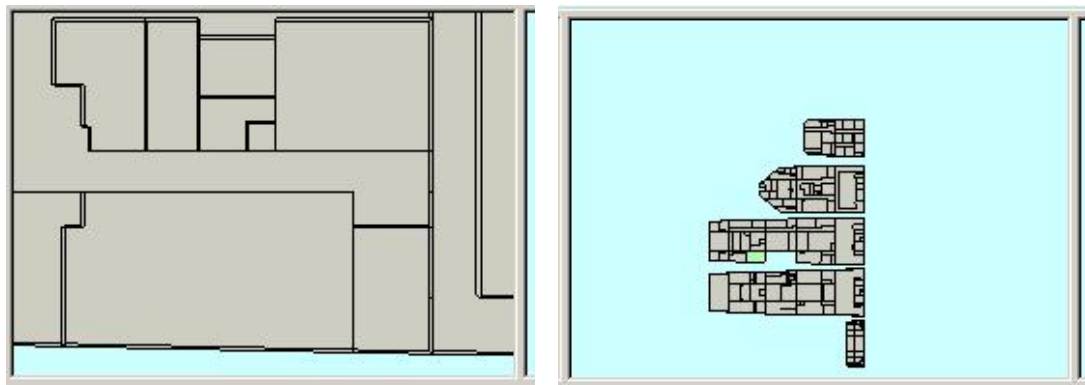
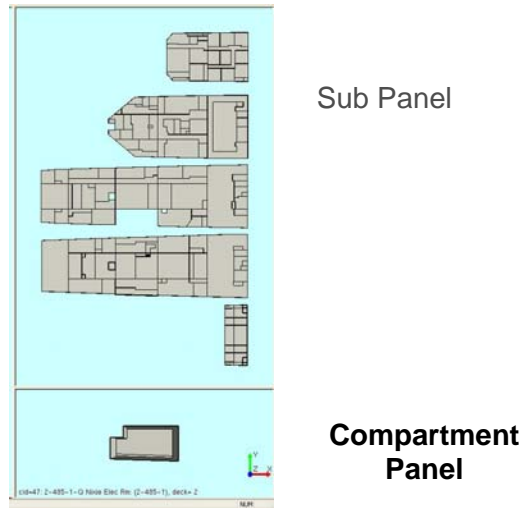


Figure 13.4 Zooming the Floor Plan View

### 13.3 Compartment Panel

The Compartment panel ( Figure 13.5) shows a single compartment view. This allows more detailed viewing of the surfaces (walls) which make up the compartment and is where the selection of individual surfaces for specifying damage occurs. See Section 8.1.4 for more details. In this view, the compartment can be rotated, zoomed, and moved similar to the main 3D view with the left, middle, and right mouse buttons.



The compartment to be displayed is selected in the Floor Plan view (Section 13.2), 3D main view (Section 13.1), Compartment Tree Browser (Section 10.0), or Show Compartment Tool (Section 9.10). In the bottom right corner of the panel the compartment id, name, and deck number of the selected compartment are displayed. The current orientation of the compartment is displayed in the right bottom corner.

Figure 13.5 Compartment Panel (Right bottom)

## 14.0 DISPLAY ADJUSTMENT TOOLS

Simultaneously displaying color (temperature) and opacity (smoke) is challenging. If one allows the condition of no visibility (i.e. visibility below a threshold) to be represented as a totally opaque compartment, then the temperature will be represented by a fully saturated (i.e. bright) color. This is counterintuitive, since a compartment full of smoke is expected to be dark. On the other hand, if we allow the compartment full of smoke to be very dark, then the information about the temperature is lost, because color is not visible. A compromise must be found.

Before color (or opacity) mapping, the parameters to be displayed are normalized (using the range values described in section 12.1.3). Then, somewhat arbitrarily, the high value of temperature is mapped to 75% of color saturation, and the high value of visibility is mapped to 95% of opacity as shown in Figure 14.1. These experimentally selected values result in a realistic representation of smoke while providing perceptible information about the temperature.

Using the Display adjustment tools, this mapping can be adjusted to the user's liking.

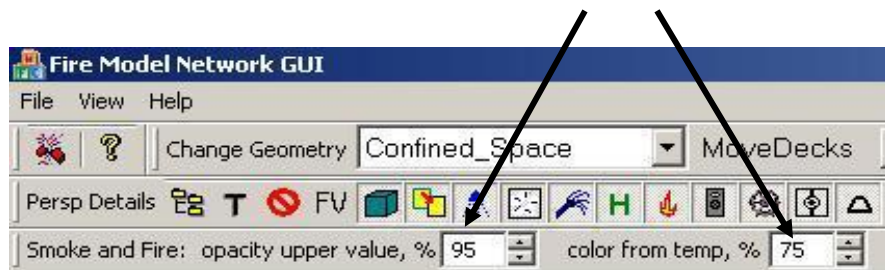


Figure 14.1 Display Adjustment Tool



## **15.0 SUMMARY**

This manual describes the functionality of the Fire Model Network GUI 2.4 developed by Mississippi State University in conjunction with Hughes Associates, Inc. and the Naval Research Laboratory. The GUI provides an environment to setup, run, and visualize fire and smoke simulations.

For further support, please contact Tomasz Haupt at [haupt@cavs.msstate.edu](mailto:haupt@cavs.msstate.edu)

## **16.0 REFERENCES**

- [1] Floyd, J., Hunt, S., Williams, F., and Tatem, P., “Fire + Smoke Simulator (FSSIM) Version 1 – User’s Guide,” NRL/MR/6180-04-8806, 31 March 2004.
- [2] Floyd, J., Hunt, S., Williams, F., and Tatem, P., “Fire + Smoke Simulator (FSSIM), Version 1 – Theory Manual,” NRL/MR/6180-04-8765, 16 July 2004.
- [3] Haupt, T., Henley, G., Tatem, P.A., and Williams, F.W., “Creating a Digital Ship Model from AutoCAD Drawings”, NSL/MR/6180-05-8882 of June 8, 2005.

## **APPENDIX A: OVERVIEW OF V2.4 NEW FEATURES (SINCE V2.0)**

### **A.1 GUI Layout and Visualizations**

1. The screen is now split vertically, giving more space for showing the deck-by-deck view.
2. The default size, positioning, and orientation of objects have been adjusted.
3. Highlighting of objects is made consistent.
4. Reset button restores the default size and orientation of the ship as well as the original sizes of panels.
5. The fire source outline is hidden when the Fire Simulation dialog is dismissed or when surfaces and edges are hidden.
6. Moving mouse out of a panel while rotating, zooming, or translating (while mouse button is held down) now continues to perform the selected action until the button is released rather than stopping at the edge of the panel and failing to recognize the mouse button had been released outside of the panel.

### **A.2 Selection of Objects**

1. The procedure for the selection of objects has been simplified. Now it can be done in one of the following ways:
  - a. By directly clicking on the object.
  - b. By Shift-Right-Click (for backward compatibility).
  - c. Compartments: By directly clicking on the compartment in the deck-by-deck view.
  - d. Compartments: By clicking the compartment name in the Compartment Tree panel.

### **A.3 Legend and Color Mapping**

1. The implementation of the legend has been improved. This includes the option of displaying simultaneously both temperature and visibility, and integer values of variables (requires refreshing the Options.xml file).
2. The default range of the oxygen level has been adjusted.
3. Support for two color mappings is provided. Linear (“scientific”) and Threshold-based (“Tactical tool”).

### **A.4 Property Dialog and the State of the Active Elements**

1. Behavior of the property dialog has been made consistent (for example, if a new input file is open, the dialog is automatically refreshed).
2. Unnecessary (“legacy”) controls have been removed.

### **A.5 Replay and Compare**

1. The layout of the “Select Simulation” dialog (opened by clicking the “Select” button in the “Replay” and “Compare” tabs in the “Fire Simulation” dialog) has been improved, including displaying the file names without truncations.
2. In compare mode, both ships have the same size and orientation.
3. In compare mode, holding down the Ctrl key in conjunction with the normal mouse button actions (rotation, zooming, and translation) will simultaneously affect both compare panels rather than just the one the mouse is in.
4. Multi-selection of files, including simultaneous selection of simulation files to be compared, and deleting multiple files has been implemented.
5. Renaming of files and their description has been implemented.

#### **A.6 Saving and Loading Input Files and Simulations**

1. Added support for exporting and importing input files
2. Added support for exporting and importing simulation files (input and associated output file).
3. Added support for modifying filenames and simulation descriptions.

#### **A.7 Miscellaneous**

1. Handling of FSSIM failures has been improved by displaying the contents of the erroneous line in the input file (instead of timing-out).
2. All reported bugs are fixed.